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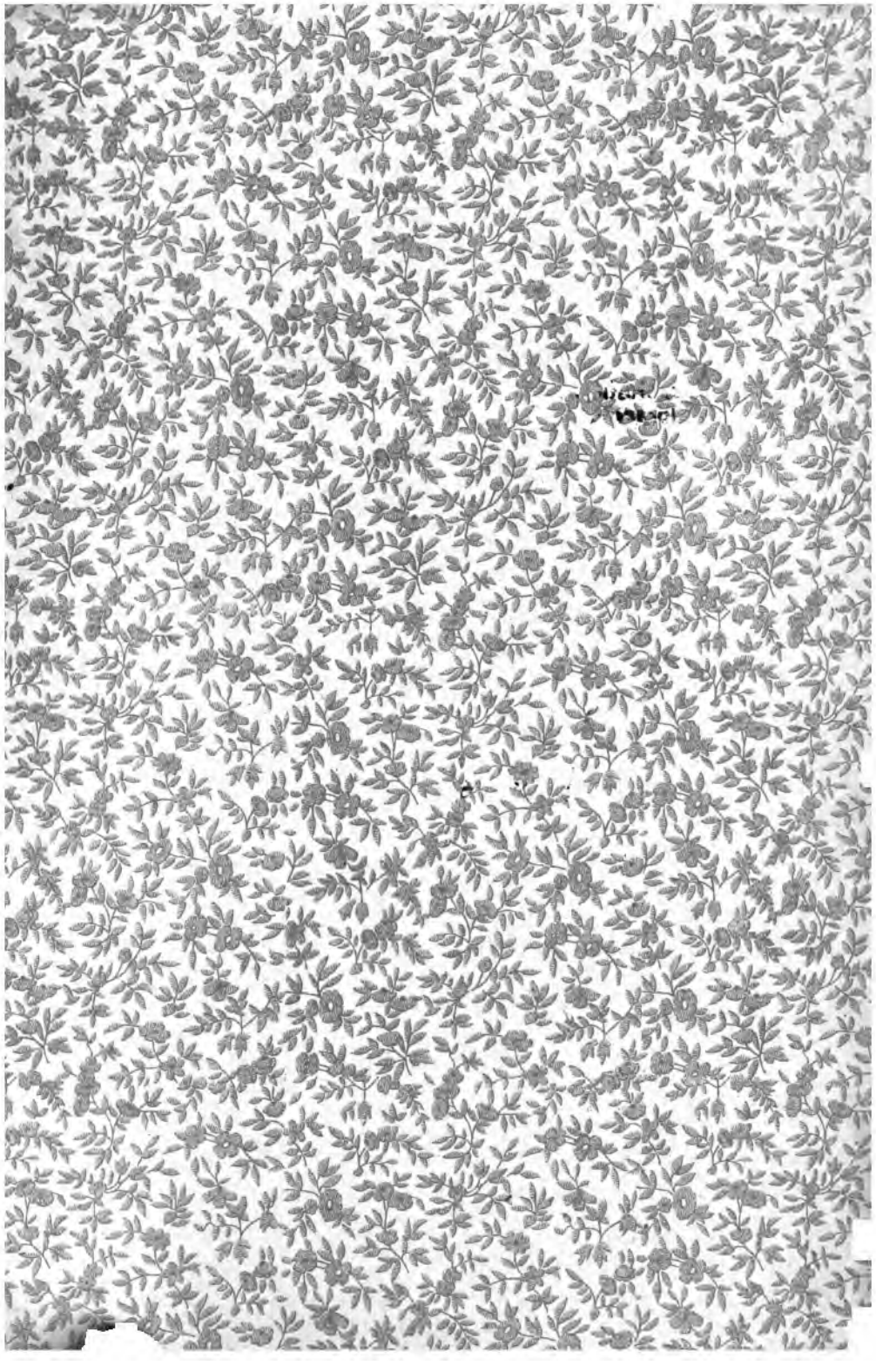

REPORT OF THE PROCEEDINGS

OF THE

Thirty-second Annual Convention

OF THE

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

(*INCORFORATED*)

HELD AT

OLD POINT COMFORT, VA.,

June 19, 20 and 21, 1899.

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AMERICAN RAILWAY
MASTER MECHANICS' ASSOCIATION

(*INCORPORATED*).

OFFICERS FOR 1899-1900.

PRESIDENT:

J. H. McCONNELL.

Omaha, Neb.

FIRST VICE-PRESIDENT:

W. S. MORRIS,

Richmond, Va.

SECOND VICE-PRESIDENT:

A. M. WAITT,

New York City.

THIRD VICE-PRESIDENT:

J. N. BARR,

Milwaukee, Wis.

TREASURER:

G. W. WEST,

Middletown, N. Y.

SECRETARY:

J. W. TAYLOR,

Chicago, Ill.

COMMITTEES FOR CONDUCTING THE BUSINESS

FOR THE

YEARS 1899-1900.

STANDING COMMITTEE.

The Extent to which the Recommendations of this Association have been put into practice.

F. A. DELANO.
A. SINCLAIR.
H. MIDDLETON.

SUBJECTS FOR 1900 CONVENTION.

1.—Relative Merits of Cast-iron and Steel-tired Wheels.

J. N. BARR.
A. M. WAITT,
H. S. HAYWARD.
A. L. HUMPHREY.
JOHN HICKEY.

2.—Advantages of Ton-mile Basis for Motive Power Statistics.

H. J. SMALL.
C. H. QUEREAU.
W. H. MARSHALL.

3.—Flanged Tire.

S. HIGGINS.
W. H. THOMAS.
WM. GARSTANG.

133372

4.—Compound Locomotives.

A. E. MITCHELL.
J. F. DEEMS.
JOHN PLAYER.
J. E. SAGUE.
J. H. SETCHEL.

5.—Piston Valves.

S. P. BUSH.
HENRY SCHLACKS.
WM. McINTOSH.

6.—Valve Oils and Various Bearing Metals.

A. W. GIBBS.
J. B. BARNES.
GEO. F. WILSON.

7.—Power Transmission by Shafting versus Electricity.

GEO. GIBBS.
F. MERTSHEIMER.
WM. RENSHAW.
W. A. NETTLETON.
R. A. SMART.

8.—Best Type of Stationary Boiler for Shop Purposes.

FRANK REARDEN.
J. J. RYAN.
J. F. DUNN.

9.—What Can the American Railway Master Mechanics' Association Do to Increase its Usefulness?

T. R. BROWNE.
G. M. BASFORD.
L. R. POMEROY.

10.—Subjects.

ROBERT QUAYLE.
G. W. RHODES.
F. D. CASANAVE.

CONSTITUTION AND BY-LAWS.

ARTICLE I.

NAME.

The name of this Association shall be the "American Railway Master Mechanics' Association."

ARTICLE II.

OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is intrusted to their care.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association, on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the Constitution and By-Laws, or authorizing the Secretary to sign the Constitution for them:

(1) Those above the rank of general foreman, having charge of the design, construction or repair of railway rolling stock.

(2) General foremen, if their names are presented by their superior officers.

(3) Two representatives from each locomotive and car-building works.

SEC. 2. Civil and mechanical engineers, or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling stock as would be of special value to the Association or railroad companies, may become associate members on being recommended by three active members. The name of such candidate shall then be referred to a committee, to be appointed by the President, which shall investigate the fitness of the candidate, and report to the Executive Committee of the Association at the next annual meeting. If the report be unanimous in favor of the candidate the name shall be submitted to ballot, and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting.

SEC. 3. All members of the Association, excepting as hereafter provided, shall be subject to the payment of such annual dues as it may be necessary to assess for

the purpose of defraying the expenses of the Association, provided that no assessment shall exceed $5 a year.

Such dues shall be payable when the amount thereof is announced by the President, at each annual meeting. Any member who shall be two years in arrears for annual dues, shall be notified of the fact, and if the arrears are not paid within three months after such notification, his name shall be taken from the roll and he be duly notified of the same by the Secretary.

SEC. 4. Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered, or he becomes disqualified by the terms of this Constitution. Members whose names have been dropped for non-payment of dues may be restored to membership by the unanimous consent of the Executive Committee on the payment of all back dues.

SEC. 5. Members of the Association who have been in good standing for not less than five years, and who through age or other cause cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at the annual meeting, be elected honorary members. The dues of the honorary members shall be remitted, and they shall have all the privileges of active members, except that of voting.

SEC. 6. Any member who, during the meetings of the Association, shall be guilty of dishonorable conduct which is disgraceful to a railroad officer and a member of the Association, or shall refuse to obey the Chairman when called to order, may be expelled by a two-thirds affirmative vote at any regular meeting of the Association held within one year from the date of the offense.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Third Vice-President, a Treasurer, and a Secretary; and they, with the exception of the Secretary, shall constitute the Executive Committee of the Association.

ARTICLE V.

DUTIES OF OFFICERS.

SECTION 1. It shall be the duty of the President to preside at all the meetings of the Association, appoint all committees—designating the chairman— and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members, and the name of the railway they each represent; to certify to the persons who are eligible as candidates for the Association's scholarships at the Stevens Institute of Technology; to receive and keep an account of all money paid to the Association and deliver the same to the Treasurer,

taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having approval of the President; to deliver all bills paid to the Secretary at the close of each meeting, taking a receipted statement of the same, and to keep an accurate book account of all transactions pertaining to his office.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable for any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, but not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

SEC. 2. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawings shall be submitted to each convention and what portion shall be printed in the annual report.

SEC. 3. Three members shall constitute a quorum for the transaction of business.

SEC. 4. The Executive Committee shall form with a committee of the Master Car Builders' Association a Joint Committee to decide on the place of meeting for the annual convention.

ARTICLE VII.

ASSOCIATION SCHOLARSHIPS.

It shall be the duty of the Secretary to issue a circular annually intimating the date and place when and where candidates may be examined for the scholarships of the Association in the Stevens Institute of Technology, Hoboken, New Jersey.

Acceptable candidates for the scholarship shall be, first, sons of members or of deceased members of the Association. If there is not a sufficient number of such applicants for the June examination, then applications will be received from other railroad employes or the sons of other railroad employes for the Fall examination. The Secretary shall issue a proper circular in this case as before. In extending the privilege outside of the families of members, preference shall be given to employes or the sons of employes, or the sons of deceased employes of the mechanical departments.

Candidates for these scholarships shall apply to the Secretary of this Association, and if found eligible shall be given a certificate to that effect for presentation to the school authorities. This will entitle the candidate to attend the preliminary examination. If more than one candidate passes the preliminary examination, the appli-

cant passing the highest examination shall be entitled to the scholarship, the school authorities settling the question.

The successful candidate shall be required to take the course of mechanical engineering.

ARTICLE VIII.

ELECTION OF OFFICERS.

SECTION 1. The officers of the Association, except the Secretary as hereinafter provided, shall be elected by ballot separately without nomination at the regular meeting of the Association, held in June of each year. A majority of all votes cast shall be necessary to an election, and elections shall not be postponed.

SEC. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

SEC. 3. A Secretary from among the members of the Association shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by vote of the majority of the Executive Committee. He shall also act as Secretary of the Executive Committee.

ARTICLE IX.

AUDITING COMMITTEE.

SECTION 1. At the first session of the annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as hereinafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suitable ones for discussion, and if so, they shall so report them to the Association.

COMMITTEES ON INVESTIGATION.

SEC. 3. When the Committee on Subjects has reported, and the Association approved of subjects for investigation, the President shall appoint special committees

to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve.

ARTICLE X.

AMENDMENTS.

SECTION 1. This Constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

BY-LAWS.

TIME OF MEETING.

I. The regular meeting of the Association shall be held annually on the third Tuesday in June.

HOURS OF SESSION.

II. The regular hours of session shall be from 9 o'clock A.M. to 2 o'clock P.M.

PLACE OF MEETING.

III. Places for holding the Annual Convention shall be selected by a Joint Committee composed of the President, three Vice-Presidents and Treasurer of this Association, and the President, three Vice-Presidents and Secretary of the Master Car Builders' Association. This Joint Committee shall meet within six months after the convention and decide upon a place of meeting, the place receiving the largest number of votes to be selected.

QUORUM.

IV. At any regular meeting of the Association, fifteen or more members entitled to vote shall constitute a quorum.

ORDER OF BUSINESS.

V. The business of the meetings of this Association shall, unless otherwise ordered by a vote, proceed in the following order:

1. Opening prayer.
2. Address by the President.
3. Acting on the minutes of the last meeting.
4. Reports of Secretary and Treasurer.
5. Assessment and announcement of annual dues.
6. Election of Auditing Committee.

7. Unfinished business.
8. New business.
9. Reports of committees.
10. Reading of papers and discussion of questions propounded by members.
11. Routine and miscellaneous business.
12. Election of officers.
13. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock M. to 1 P.M. of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association, unless otherwise provided.

DISCUSSIONS.

VII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak, and have not been heard, have spoken.

NAMES AND ADDRESSES OF MEMBERS.

ACTIVE MEMBERS.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Adams, Abraham	Great Northern	Wilmar, Minn.
1896	Adams, T. E	Great Northern	Melrose, Minn.
1888	Addis, J. W	Texas & Pacific	Marshall, Tex.
1895	Aikin, C. L	Boston & Maine	Springfield, Mass.
1887	Aldcorn, Thos		New Durham, N. J.
1892	Allen, G. S	Philadelphia & Read'g	Tamaqua, Pa.
1894	Allin, Richard	Arkansas Midland	Helena, Ark.
1895	Amann, W. E		1536 St. Charles st., Alameda, Cal.
1892	Antz, Oscar	L. S. & M. S	Cleveland, Ohio.
1887	Arp, W. C	T. H. & I	Terre Haute, Ind.
1890	Atkinson, R	Canadian Pacific	Montreal, Que.
1896	Atterbury, W. W	Pennsylvania	Altoona, Pa.
1887	Augustus, W	Keokuk & Western	Centerville, Iowa.
1886	Austin, W. L		Baldwin Loco. Works, Philadelphia, Pa.
1896	Babcock, C. M	Texas & Pacific	Gouldsboro, La.
1898	Baker, C. F.	Boston Elevated	Boston, Mass.
1894	Balkam, S. T		Calle Teatro No. 17, Monterey, N. L., Mexico.
1898	Barhydt, J. A	Buff. Roch. & Pitts	Rochester, N. Y.
1894	Barnes, Chas. H	Boston & Albany	Boston, Mass.
1888	Barnes, J. B	Wabash	Springfield, Ill.
1877	Barnett, J. Davis		Stratford, Ont.
1890	Barnum, M. K	Union Pacific	Omaha, Neb.
1890	Barr, J. N	C. M. & St. P	Milwaukee, Wis.
1899	Barrington, Edw	Vera Cruz & Pacific	City of Mexico, Mex.
1896	Barrow, A. R	Northwestern	Lahore, India.
1895	Bartlett, Henry	Boston & Maine	Boston, Mass.
1899	Bates, F. L	Southern Pacific	San Francisco, Cal.
1889	Battye, John E	Norfolk & Western	Roanoke, Va.
1895	Bay, J. P	Union Pacific	Laramie, Wyo.
1885	Bean, John	Clev. Canton & South'n	Canton, Ohio.
1889	Bean, S. L	Northern Pacific	Brainerd, Minn.
1892	Beattie, A. L	New Zealand Gov't	Addington, N. Z.
1899	Beauclerk, T	Central Argentino	Rosario de Santa Fe, Arg. Rep., S. A.
1894	Beaumont, J. G	Southern R'ys of Peru	Arequipa, Peru.

JOINED.	NAME.	ROAD.	ADDRESS.
1892	Bechhold, H. G.	Cleveland Frog & Crossing Co.	Cleveland, Ohio.
1885	Beckert, Andrew	Louisville & Nashville.	Decatur, Ala.
1896	Belcher, A. W	Ulster & Delaware	Rondout, N. Y.
1892	Beltz, A. J.	Del. Sus. & Schuylkill	Drifton, Pa.
1892	Benson, A. E	Ulster & Delaware	Rondout, N. Y.
1891	Berry, J. H.	C. N. O. & T. P.	Chattanooga, Tenn.
1892	Billingham, Jos	Baltimore & Ohio.	Glenwood Shops, Pittsburgh, Pa.
1879	Bisset, John	W. C. & A.	Wilmington, N. C.
1899	Bissett, J. R	Atlantic Coast Line	South Rocky Mountain, N. C.
1872	Blackall, R. C	Delaware & Hudson.	Albany, N. Y.
1883	Blackwell, Chas		1010 Grand ave, Toledo, Ohio.
1898	Bocquet, H. C	Leopoldina R'y	Rio de Janeiro, Brazil, S. A.
1899	Boldridge, B. M.	So. R'y in Kentucky.	Louisville, Ky.
1869	Boon, J. M.		5117 Madison ave., Chicago, Ill.
1893	Bond, I	Erie	Susquehanna, Pa.
1899	Bonner, John	California Northwestern.	Tiburon, Cal.
1897	Bowles, C. K	Farmville & Powhatan	Chester, Va.
1890	Boyle, Wilson L.	N. Y. Sus. & Western.	Jersey City, N. J.
1895	Bradeen, A. A	L. S. & M. S.	Cleveland, Ohio.
1895	Bradeen, J. O.	L. S. & M. S.	Norwalk, Ohio.
1888	Bradley, W. F	Ann Arbor	Durand, Mich.
1894	Branch, Geo. E	Brooklyn Wharf & Warehouse Terminal	Brooklyn, N. Y.
1896	Brangs, P. H.	D. L. & W.	Hoboken, N. J.
1893	Brantner, Z. T.	Baltimore & Ohio.	Brunswick, Md.
1892	Brehm, W. H.	Mo. Kan. & Texas	Parsons, Kan.
1897	Briggs, D. D	Louisville & Nashville.	New Orleans. La.
1879	Briggs, R. H	K. C. M. & B.	Memphis, Tenn.
1898	Bronner, E. D	Michigan Central	Detroit, Mich.
1887	Brooke, Geo. D	St. Paul & Duluth	Gladstone, Minn.
1890	Brown, Angus	Wisconsin Central	Waukesha, Wis.
1892	Brown, David	D. L. & W.	Scranton, Pa.
1887	Brown, F. R. F.	22 Street Railway Chambers	Montreal, Can.
1891	Brown, J. L		Water Works, Allegheny, Pa.
1896	Brown, M. D	Mo. Kan. & Texas	New Franklin, Mo.
1891	Brown, W. A	Buffa. & Susquehanna.	Galeton, Pa.
1895	Browne, T. R.	Pennsylvania.	Altoona, Pa.
1882	Brownell, F. G.		Muncie st., Muncie, Ind.
1897	Bruce, Geo. A		526 Cedar st., St. Paul, Minn.
1890	Bruck, Henry T.	Cumb. & Penna.	Mt. Savage, Md.
1882	Bryan, H. S	Duluth & Iron Range.	Two Harbors, Minn.
1887	Buchanan, Wm		New York City.
1896	Buck, Geo. W	Great Northern.	St. Paul, Minn.
1893	Buckalew, J. H	Mem. & Charleston	Memphis, Tenn.
1891	Burns, C. H	Hous. & Tex. Central.	Houston, Tex.
1893	Bush, S. P	P. C. C. & St. L.	Columbus, Ohio.
1870	Bushnell, R. W	B. C. R. & N.	Cedar Rapids, Iowa.

JOINED.	NAME.	ROAD.	ADDRESS.
1893	Butcher, Geo. W	San Antonio & A. Pass.	San Antonio, Tex.
1861	Butler, L. M	N. Y.. New Haven & Hartford	Valley Falls, R. I.
1896	Callander, R. J		Pernambuco, Brazil, S. A.
1883	Campbell, John	Lehigh Valley	Buffalo, N. Y.
1891	Campbell, John D		657 Quincy ave., Scranton, Pa.
1896	Cannon, T. E	Great Northern	Barnesville, Minn.
1889	Carmody, T		Cleveland, Ohio.
1896	Carr, Jas	St. L. I. M. & S	Van Buren, Ark.
1885	Carson, M. T	Mobile & Ohio	Mobile, Ala.
1889	Casanave, F. D	Pennsylvania	Altoona, Pa.
1890	Casey, J. J	Haskell & Barker	Michigan City, Ind.
1892	Chamberlin, E		757 Prospect ave., Buffalo, N. Y.
1893	Chambers, Jno. S	Central R. R. of New Jersey,	Elizabethport, N. J.
1878	Chapman, T. L	Southern R'y	Washington, D. C.
1897	Chase, F. A	Hannibal & St. Joseph.	St. Joseph, Mo.
1893	Childs, H. A	Erie	Jersey City, N. J.
1898	Christopher, J	Toronto, Hamilton & Buffalo,	Hamilton, Ont., Can.
1899	Christie, W. K	Chicago & West Michigan,	Muskegon, Mich.
1896	Chubb, Thos. L	Buenos Ayres W	La Plata, Ar. Rep., S. A.
1899	Clark, F. H	Chicago, Burlington & Quincy,	Chicago, Ill.
1886	Clark, Isaac W	C. F. & Y. V	Fayetteville, N. C.
1897	Clarke, Owen	Texas & Pacific	Marshall, Tex.
1893	Cleaver, F. C	L. E. & St. L. Con	Princeton, Ind.
1892	Clifford, C. J		South Chicago, Ill.
1887	Clifford, J. G		Tenth and Kentucky sts., Louisville, Ky.
1887	Cloud, John W		82 York Road, King's Cross, London, Eng.
1896	Coale, J. M	Northern Central	Baltimore, Md.
1895	Cockfield, Jos	Chicago & North-Western,	Clinton, Iowa.
1891	Cockfield, Wm	Mexican Central	San Luis Potosi, Mex.
1896	Cole, F. J		Rogers Locomotive Works, Paterson, N. J.
1891	Collinson, Jas	G. C. & S. F	Galveston, Tex.
1890	Conolly, J. J	D. S. S. & A	Marquette, Mich.
1892	Conroe, I	A. T. & S. F	Newton, Kan.
1899	Cook, A. B	Central Argentino.	Rosario de Santa Fe, Arg. Rep., S. A.
1879	Cook, John S	Georgia	Augusta, Ga.
1879	Cooke, Allen		Danville, Ill.
1891	Cooke, W. I	Chicago & Eastern Ill.	Momence, Ill.
1898	Cooper, C. J	Toledo & Ohio Central.	Kenton, Ohio.
1898	Cooper, D. S	Rich. Fred. & Potomac.	Richmond, Va.
1876	Cory, C. H	C. H. &. D	Lima, Ohio.
1892	Crawford, S. B	Balt. & Ohio	Parkersburg, W. Va.
1885	Cromwell, A. J		1411 Hollins st., Baltimore, Md.
1893	Cross, W	Canadian Pacific	Winnipeg, Man.
1883	Cullen, Jas	N. C. & St. L	Nashville, Tenn.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Cullinan, J.	Norfolk & Western	Portsmouth, Ohio.
1899	Cunningham, Jas	Choctaw, Oklahoma & Gulf	Shawnee, O. T.
1872	Cushing, G. W.		Evanston, Ill.
1888	Dallas, Wilber C	Galena Oil Co.	Franklin, Pa.
1890	Davies, J. M.		56 Broad st., Plattsburgh, N. Y.
1892	Davis, Ed E.	N. Y. Cent. & Hudson River	New York, N. Y.
1899	Davis, M. R.	Portland & Rum. Falls.	Rumford Falls, Me.
1893	Davis, Wm. J.	Pitts & Western	Foxbury, Pa.
1897	Dawson, E.		1230 Michigan avenue, Kansas City, Mo.
1894	Deeble, Wm. R	Tasmania Govt	Strahan, Tasmania.
1891	Deems, J. F	C. B. & Q.	West Burlington, Iowa.
1896	De Gress, C.	Mex. Nat. Construc. Co.	Colima, Mex.
1897	De Haven, C. A.	K. C. P. & G.	Shreveport, La.
1892	Dehn, F. H		Walnut Springs, Texas.
1897	Delaney, C. A.	Supt. Dickson Loco. Works	Scranton, Pa.
1895	Delaney, H.	Phila. & Reading	Philadelphia, Pa.
1899	Delano, F. A	C. B. & Q.	Chicago, Ill.
1894	De Witt, Chas. H.	Lehigh Valley	Delano, Pa.
1896	Dickerson, S. K.	Norfolk & Western	Roanoke, Va.
1887	Dickson, G. L	Dickson Loco. Works	Scranton, Pa.
1894	Dixon, W. F	Sormovo Co.,	Philadelphia, Pa.
1897	Doebler, C. H.	Wabash	Springfield, Ill.
1898	Dolan, S. M.	E. St. Louis Conn. & Transfer	East St. Louis, Ill.
1896	Donahue, Geo	Erie	Cleveland, Ohio.
1880	Dotterer, D. H		45 Wellington ave., Rochester, N. Y.
1893	Dow, Jas. M.	Tol. & Ohio Central	Kenton, Ohio.
1890	Downing, T.		Station E. Minneapolis, Minn.
1899	Downing, T. M	Detroit & Lima Nor.	Tecumseh, Mich.
1896	Driscoll, J. L.	Catskill Mountain	Catskill, N. Y.
1893	Drury, Michael J.	A. T. & S. F	Arkansas City, Kan.
1896	Dunn, J. F	Oregon Short Line	Salt Lake City, Utah.
1869	Elliott, Henry		East St. Louis, Ill.
1895	Ellis, John	Maine Central	Waterville, Me.
1893	Ellis, John J.	C. St. P. M. & O.	St. Paul, Minn.
1897	Elvin, A. G	Ches. & Ohio	Huntington, W. Va.
1893	English, H. W.	Birmingham R'y & Elec. Co.,	Birmingham, Ala.
1893	English, Richard	Rio Grande Western	Helper, Utah.
1881	Ennis, W. C.		North Paterson, N. J.
1898	Erskine, A. S.	Wiscasset & Quebec	Wiscasset, Me.
1892	Esson, R. C	Southern Pacific	Newark, Cal.
1898	Ettinger, R. L	C. C. C. & St. L.	Indianapolis, Ind.
1885	Fenwick, A		Fort Howard, Wis.
1885	Ferguson, G. A.		48 Staniford st., Boston, Mass.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Fisher, G. P.	Texas Midland	Terrell, Texas.
1892	Fitzmorris, Jas	Chicago Junction	Union Stock Yards, Chicago, Ill.
1895	Foller, P. P	W. N. Y. & Pa	Oil City, Pa.
1896	Foque, T. A	M. St. P. & S. Ste. M.	Minneapolis, Minn.
1888	Forsyth, Wm		Aurora, Ill.
1875	Foster, W. A	Fall Brook R'y Co	Corning, N. Y.
1890	Foulk, John	Litch. Car. & Western	Litchfield, Ill.
1877	Fowle, I. W		Riverside, Cal.
1891	French, R. E	Southern Pacific	Kern, Cal.
1898	Frey, N	Chgo. Bur. & Northern	LaCrosse, Wis.
1890	Fuller, C. E	Central Vermont	St. Albans, Vt.
1872	Fuller, Wm		213 Kennard st., Cleveland, Ohio.
1893	Gage, George W	St. Louis Southwestern	Pine Bluff, Ark.
1897	Gaines, F. F	Lehigh Valley	South Easton, Pa.
1898	Galbraith, H. D	St. Louis Southwestern	Texarkana, Ark.
1891	Galbraith, R. M	St. Louis Southwestern	Pine Bluff, Ark.
1897	Gardner, A	C. & C. V	Cooperstown, N. Y.
1893	Garrick, J. R	Tex. & New Orleans	Beaumont, Tex.
1892	Garrison, P. E	Fonda, Johnstown & Gloversville	Gloversville, N. Y.
1887	Garştang, Wm.	C. C. C. & St. L	Indianapolis, Ind.
1886	Gentry, T. W	Richmond Loco. Wks.	Richmond, Va.
1899	Gibb, T. W	Colorado & Southern	Trinidad, Colo.
1888	Gibbs, A. W	Pennsylvania	Altoona, Pa.
1890	Gibbs, George	Baldwin Loco. Wks	Philadelphia.
1896	Gill, Jno	C. R. I. & P	Trenton, Mo.
1891	Gillis, H. A	Richmond Loco. Wks.	Richmond, Va.
1883	Gilmore, W. L	L. S. & M. S	Elkhart, Ind.
1893	Gilmour, George	N. Y. Telephone Co	15 Dey st., New York.
1890	Givin, F. A	B. St. M. & S.-W	St. Mary's, Pa.
1897	Glaser, J	Cleveland & Marietta	Cambridge, Ohio.
1891	Glass, John C	Allegheny Valley	Verona, Pa.
1880	Gordon, H. D		71 John st., New Yoak.
1879	Gordon, James T	Concord	Concord, N. H.
1892	Graham, Charles, Jr.	D. L. & W	Kingston, Pa.
1894	Graham, J. A	Clev. Lorain & W.	Lorain, Ohio.
1894	Grant, A. S	H. E. & W. T	Houston, Tex.
1889	Greatsinger, J. I	D. & I. Range	Duluth, Minn.
1897	Greaven, Luis	Western R'y of B. A	Caballito, Buenos Ayres, Arg. Rep. S. A.
1895	Green, Wilbur	S. A. & A. P	Yoakum, Tex.
1896	Greenwood, Alfred W.	East Broad Top.	Rockhill Furnace, Pa.
1891	Griffin, B. F	Duluth, Miss. R. & N.	Swan River, Minn.
1885	Griffith, Fred B		Buffalo, N. Y.
1893	Gross, R. J		Brooks Loco. Works, Dunkirk, N. Y.
1896	Groves, J. R	St. L. & S. F	Springfield, Mo.

JOINED.	NAME.	ROAD.	ADDRESS.
1880	Hackney, Clem	Fox Solid	Pressed Steel Co., Joliet, Ill.
1875	Haggett, J. C		Dunkirk, N. Y.
1893	Hainen, J	Erie	Port Jervis, N. Y.
1898	Hair, John	Balto. & Ohio S.-W	Chillicothe, Ohio.
1896	Hall, J. W	St. L. S.-W	Commerce, Tex.
1891	Hancock, Geo. A	A. T. & S. F	Topeka, Kan.
1893	Hancock, Wm. S	Santa Fe Pacific	Needles, Cal.
1896	Hanglin, J. A	Hot Springs	Malvern, Ark.
1899	Hansgen, J. A	Findlay, Ft. W. & West.	Findlay, Ohio.
1893	Hardie, Jas		Hardie & Co. Valparaiso, Chili.
1896	Harrison, Jno	San Paulo	San Paulo, Brazil, S. A.
1898	Harrison, F. J	Buffa., Roch., & Pittsburg.	Rochester, N. Y.
1889	Haskell, B	Chic. & W. Mich	Grand Rapids, Mich.
1888	Hassman, Wm	Illinois Central	Paducah, Ky.
1875	Hatswell, T. J	F. & P. M	Saginaw, E. S., Mich.
1897	Hatswell, T. J., Jr	F. & P. M	Saginaw, E. S., Mich.
1895	Hawksworth, D	B. & M. River	Plattsmouth, Neb.
1898	Hayden, J. C	Mexican National	Acambara, Mex.
1896	Hayward, H. S	Pennsylvania	Jersey City, N. J.
1891	Hedley, F	Lake Street Elevated	Chicago, Ill.
1896	Heers, L. B	C. N. Y. & W. R. R	Angelica, N. Y.
1887	Heintzleman, T. W	Southern Pacific	Sacramento, Cal.
1888	Hemphill, W. J	St. L. Peoria & North'n.	Springfield, Ill.
1886	Hendee, A	Panama	Colon, U. S. C.
1892	Henderson, G. R	Chgo. & North-West'n.	Chicago, Ill.
1897	Hennessey, T. J	Michigan Central	Jackson, Mich.
1897	Hepburn, G. W	Ches. & Ohio	Hinton, W. Va.
1898	Herbert, R. L	G. H. & S. A	El Paso, Tex.
1892	Herr, Edwin M	Westinghouse Air Brake Co.,	Wilmerding, Pa.
1871	Hewitt, John	1323 So. Jefferson st.,	St. Louis, Mo.
1895	Hibbard, H. Wade	Cornell University	Ithaca, N. Y.
1883	Hickey, John	Rio Grande Western	Salt Lake City, Utah.
1890	Higgins, S	Lehigh Valley	S. Bethlehem, Pa.
1887	Hill, Jas. W	P. & Pekin Union	Peoria, Ill.
1892	Hill, Rufus	Pennsylvania	Pavonia, N. J.
1897	Hinchey, Jas	Cent. Vermont	New London, Conn.
1892	Hinckley, A. C	St. Jo. & Gr. Island	St. Joseph, Mo.
1894	Hiser, Edwin C		Lockport, N. Y.
1883	Hoffecker, W. L		Elizabethport, N. J.
1899	Hoffman, R. F	A. T. & S. F	Topeka, Kan.
1896	Hogsett, C. E	Moctezuma Copper Co.,	Bisbee, Arizona.
1892	Holland, W. D		Moberly, Mo.
1885	Holman, W. L	Pennsylvania	Renovo, Pa.
1890	Homer, John C	Cin. P. & Virginia	Portsmouth, Ohio.
1896	Hopwood, Jno	Argentine Gt. West.	Mendoza, Argentine Rep., S. A.
1896	Horrigan, Jno	E. J. & E. R. R	Joliet, Ill.

JOINED.	NAME.	ROAD.	ADDRESS.
1892	Howard, C. H.	Union Trust Bldg.,	St. Louis, Mo.
1896	Howard, Jno.	West Shore	New Durham, N. J.
1890	Hudson, E. E.	C. C. C. & St. L.	Bellefontaine, Ohio.
1899	Hudson, H. G.	C. C. C. & St. L.	Mt. Carmel, Ill.
1892	Hudson, W. H.	Southern	Spencer, N. C.
1890	Hufsmith, F.	I. & G. N	Palestine, Tex.
1890	Humphrey, A. L	Colorado Midland	Colorado City, Colo.
1896	Hyndman, F. T.	Pitts. & Western R'y.	Allegheny, Pa.
1896	Inge, T. S.	Southern	Columbia, S. C.
1888	Jackson, O. H	S. F. P. & P.	Prescott, Ariz.
1896	James, Geo.	N. Y. C. & St. L.	Stony Island, Ill.
1890	Jennings, Wm.	Mexican International.	Ciudad Porfirio, Diaz, Mex.
1893	Jerome, E. W.		557 Second st., Albany, N. Y.
1896	Johnson, A. B.	Baldwin Loco. Works,	Philadelphia, Pa.
1878	Johnson, J. B.	Arkansas Midland	Helena, Ark.
1887	Johnson, L. R.	Canadian Pacific	Vancouver, B. C.
1898	Johnson, R. H	Atlanta & West Point. Western of Alabama.	Montgomery, Ala.
1887	Johnstone, F. W.	Mexican Central	City of Mexico, Mex.
1888	Joughins, G. R.	Intercolonial	Moncton, N. B., Can.
1896	Justice, D. J.	Atlantic Coast Line	Florence, S. C.
1890	Kalbaugh, I. N.	Balto. & Ohio	Newark, Ohio.
1896	Keegan, Jas. A.	C. C. C. & St. L.	Riverside, Cincinnati, Ohio.
1892	Keegan, Jas. E.	G. R. & Ind.	Grand Rapids, Mich.
1890	Keith, J. M.	W. R'y of Gautemala.	San Filipe, Gautemala, C. A.
1896	Kells, Willard	Erie	Meadville, Pa.
1896	Kelly, Wm.	Great Northern	Hillyard, Wash.
1894	Kennedy, Jas	Jamaica	Kingston, Jamaica.
1893	Kenney, Geo. W.	Rutland	Rutland, Vt.
1890	Killen, W. E.	C. P. & St. L. St. L. C. & St. P. Alton Terminal	Jacksonville, Ill.
1898	King, D. M.	Raleigh & Gaston	Raleigh, N. C.
1892	Kirk, John	A. T. & S. F.	Arkansas City, Kan.
1892	Kistler, Lewis		Syracuse, N. Y.
1890	Knapp, G	Humeston & Shenandoah	Shenandoah, Iowa.
1898	Laing, W.	Texas & Pacific	Texarkana, Tex.
1898	Lake, E. M.	Gulf & Ship Island	Gulfport, Miss.
1895	La Lime, E.	Ohio River	Parkersburg, W. Va.
1896	Lamplugh, Q.	Colo. & N.-W.	Boulder, Colo.
1894	Lang, V. B.	Cin., N. O. & Tex. Pac.	Chattanooga, Tenn.

JOINED.	NAME.	ROAD.	ADDRESS.
1899	Langston, C. J.	Miss. River, Hamburg & West	Hamburg, Ark.
1888	Lape, C. F	So. Cal	San Bernardino, Cal.
1895	Lauer, F. G.	B. R. & Pittsburgh	Du Bois, Pa.
1889	Lavery, W.	Erie	New York, N. Y.
1891	Lawler, F. M.	C. C. C. & St. L.	Brightwood, Ind.
1891	Lawes, T. A.	C. & E. I	Danville, Ill.
1896	Lawrence, J. L.	Cumb. Valley	Chambersburg, Pa.
1890	Leach, H. L.	Room 45, Mason Bldg., Boston, Mass.	
1892	Lee, C. W.	Southern	Greensboro, N. C.
1896	Leech, C. C		88½ Putnam st., Buffalo, N. Y.
1883	Leeds, Pulaski	Louisville & Nashville	Louisville, Ky.
1888	Leigh, F. J		Can. Loco. Works, Kingston, Ont.
1890	Leonard, A. G.	Chicago Junction	Chicago, Ill.
1873	Lewis, W. H	D. L. & W	Hoboken, N. J.
1876	Lewis, W. H	Norfolk & Western	Roanoke, Va.
1896	Lindoff, Geo.	Montana Union	Anaconda, Mont.
1896	Linstrom, Chas	Yazoo & Miss. Valley	Vicksburg, Miss.
1890	Lloyd, T. S.	Ches. & Ohio	Richmond, Va.
1890	Logan, P. A	Can. Eastern	Gibson, N. B.
1895	Lonergan, P. T	R. W. & O	Oswego, N. Y.
1868	Losey, Jacob	Louisville Steam Forge Co.,	Louisville, Ky.
1899	Lovell, Alfred	Northern Pacific	St. Paul, Minn.
1897	Lucas, W. O.	Central Argentine	Rosario, Arg. Rep., S. A.
1894	Lyon, Tracy	Chic. Gt. Western	St. Paul, Minn.
1885	Lythgoe, Joseph	R. I. Loco. Works,	Providence, R. I.
1887	Macbeth, Jas.	N. Y. Central	Buffalo, N. Y.
1892	Macdonald, Aug. V.	New Zealand R'ys	Newmarket, Auckland, N. Z.
1890	Macfarlane, T. W		Assumption, Ill.
1899	Machesney, A. G.	Cornwall	Lebanon, Pa.
1876	Mackenzie, John	N. Y. C. & St. L.	Cleveland, Ohio.
1892	Mackinnon, Geo. S.	Canadian Pacific	Toronto Junction, Ont.
1896	Maher, P.	Ind. Ill. & Iowa	Kankakee, Ill.
1896	Mahl, F. W.	So. Pac	Sacramento, Cal.
1899	Malone, I. M	Honduras	Puerto Cortez, Spanish Honduras.
1895	Mallinson, E. P	Brooklyn Elevated	2075 B'way, Brooklyn, N. Y.
1894	Manchester, A. E.	C. M. & St. P. R'y.	Milwaukee, Wis.
1893	Manning, J. H	Union Pacific	Cheyenne, Wyo.
1898	Marchbanks, James	Wellington & Manawatn.	Wellington, N. Z.
1896	Marden, J. W.	Fitchburg	Boston, Mass.
1897	Marshall, B. F	Clev. Ak. & Columbus.	Mt. Vernon, Ohio.
1890	Marshall, E. S	Manager, Western R'y Equipment Co.,	St. Louis, Mo.
1891	Marshall, W. H.	Lake Shore & Mich. So.	Cleveland, Ohio.
1888	Maver, A. A.	Grand Trunk	Stratford, Ont.
1892	McCann, Thos	Geo. Creek & Cum	Cumberland, Md.

JOINED.	NAME.	ROAD.	ADDRESS.
1891	McConnell, J. H	Union Pacific	Omaha, Neb.
1896	McCormick, A	Rock Island & Peoria	Peoria, Ill.
1892	McCuen, J. P	C. N. O. & T. P	Ludlow, Ky.
1891	McDonough, James	Gulf, Colo. & S. F	Galveston, Tex.
1892	McDuff, Allan	B. C. R. & N	Cedar Rapids, Iowa.
1893	McElvaney, C. T	American Cotton Co.,	Dennison, Tex.
1890	McIntosh, Wm	Central R. R. of N. J	Jersey City, N. J.
1893	McKee, G. S	Wabash	Ft. Wayne, Ind.
1896	McLean, W. J	Bell. Bay & Brit. Col	New Whatcom, Wash.
1894	McMasters, Chas. J	Benn. & Rutland	Rutland, Vt.
1896	McNabb, T	Gt. Falls & Canada	Lethbridge, Alberta, Kan.
1890	McNaughton, Jas		Brooks Loco. Works, Dunkirk, N. Y.
1888	Medway, John		Swift & Co., Chicago, Ill.
1895	Mellin, C. J		Richmond Loco. Works, Richmond, Va.
1892	Mertsheimer, F	K. C. Pittsburg & Gulf	Kansas City, Mo.
1887	Michael, J. B	Southern	Knoxville, Tenn.
1883	Middleton, Harvey	Balto. & Ohio	Baltimore, Md.
1885	Millen, Thos	Metropolitan Street R'y,	106 W. 51st st., New York.
1889	Miller, E. A	N. Y. C. & St. L	Conneaut, Ohio.
1890	Miller, Geo. A	Florida East Coast	St. Augustine, Fla.
1896	Miller, G. W	Erie	Elmira, N. Y.
1898	Miller, Robt	Michigan Central	Detroit, Mich.
1893	Minshull, P. H	N. Y. O. & W	Middletown, N. Y.
1891	Minto, H. M	Louisville & Nashville	Mobile, Ala.
1888	Minton, A. B	Mobile & Ohio	Murphysboro, Ill.
1892	Mitchell, Alva	A. T. & S. F	Ottawa, Kan.
1870	Mitchell, A	Lehigh Valley	Wilkesbarre, Pa.
1892	Mitchell, A. E	Erie	New York City.
1898	Moler, A. L		Baldwin Loco. Works, Philadelphia, Pa.
1890	Monkhouse, H	Chicago & Alton	Bloomington, Ill.
1888	Montgomery, Wm	Cent. of N. J	Manchester, N. J.
1890	Moore, J. H	Erie	Buffalo, N. Y.
1895	Moraga, Anselmo	Chilian State	Santiago, Chili.
1896	Moran, Robt	Louisville & Nashville	Bowling Green, Ky.
1887	Morris, W. S	Ches. & Ohio	Richmond, Va.
1898	Morrison, T. F	South Side Elevated	Chicago, Ill.
1890	Morse, F. W	Grand Trunk	Montreal, Can.
1899	Muhlfeld, J. E	Grand Trunk	Port Huron, Mich.
1890	Murphy, P. H	Murphy Car Roof Co.,	East St. Louis, Ill.
1894	Nettleton, W. A	K. C. Ft. S. & M	Kansas City, Mo.
1898	Neubert, G. T	Atch. Topeka & S. F	Arkansas City, Kan.
1892	Neuffer, John G	B. & O. S.-W	Cincinnati, Ohio.
1898	Newell, T. W	Atlanta, Kn'xv'e & N'n	Blue Ridge, Ga.
1896	Neward, F. H	Pontiac, Ox. & North'n	Pontiac, Mich.
1896	Nicholas, J. O	Mexican National	Tolucca, Mex.

JOINED.	NAME.	ROAD.	ADDRESS.
1890	Nicholls, J. Mayne	Nitrate R'ys	Iquique, Chili.
1875	Noble, L. C.	A. French Spring Co.,	1414 Fisher Bldg., Chicago.
1899	Nolan, J. P.	Southern Pacific	Algiers, La.
1896	Norsworthy, N. W.	Norfolk & Western	Crewe, Va.
1896	Nuttall, W. H	Manistee & N. Eastern	Manistee, Mich.
1890	O'Brien, John	Rich. & Petersburg	Manchester, Va.
1890	O'Herin, Wm	Mo. Kan. & Tex	Parsons, Kan.
1895	O'Leary, D	Seattle & International	Seattle, Wash.
1895	Orland, W. P.	C. C. C. & St. L	Mattoon, Ill.
1897	Osborne, H.	Canadian Pacific	Montreal, Can.
1897	Owens, W. H	Southern	Manchester, Va.
1890	Page, H. D	Chic. & N.-Western	Baraboo, Wis.
1891	Pattee, J. O.	Great Northern	St. Paul, Minn.
1879	Patterson, J. S		Galena Oil Co., Cincinnati, Ohio.
1885	Paxson, L. B	Phila. & Reading	Reading, Pa.
1891	Paxton, Thos	A. T. & S. F	Ft. Madison, Iowa.
1897	Pease, F. J	T. St. L. & K. C.	Frankfort, Ind.
1887	Peck, Peter H	C. & W. I. & Belt	Chicago, Ill.
1899	Pennington, J. H	Dela., Susq. & Schuyl.	Drifton, Pa.
1897	Peyton, H. T.	A. T. & S. F.	Raton, N. M.
1897	Pflager, H. M.		Pullman Palace Car Co., Chicago, Ill.
1878	Pilsbury, Amos	Maine Central	Portland, Me.
1885	Pitkin, A. J		Schenectady Loco. Works, Schenectady, N. Y.
1874	Place, T. W	Illinois Central	Waterloo, Iowa.
1881	Player, John	A. T. & S. F	Topeka, Kan.
1897	Pollitt, Harry	Great Central	Gorton, Manchester, Eng.
1893	Potter, G. L	Penna. Lines	Fort Wayne, Ind.
1897	Potton, J.	Texas & Pacific	Big Springs, Tex.
1891	Prescott, C. H	Spokane Falls & Nor	Spokane Falls, Wash.
1894	Priest, Edwin	Boston & Albany	East Albany, N. Y.
1881	Pringle, R. M.		Second and Carr sts., St. Louis, Mo.
1890	Purves, T. B., Jr	Boston & Albany	Springfield, Mass.
1888	Quayle, Robert	Chgo. & North-Western	Chicago, Ill.
1895	Quereau, C. H.	Denver & Rio Grande	Denver, Colo.
1888	Quinn, John A.	Ches. & Ohio	Clifton Forge, Va.
1896	Rainsford, Henry J	Montana Union	Anaconda, Mont.
1890	Randolph, L. S	Virginia Polytechnic Institute,	Blacksburg, Va.
1892	Reading, R. B		Passaic, N. J.
1891	Rearden, Frank	Missouri Pacific	St. Louis, Mo.
1895	Redding, M. J	Louisiana & Arkansas	Stamps, Ark.
1888	Reed, W. T	Seaboard Air Line	Portsmouth, Va.

JOINED.	NAME.	ROAD.	ADDRESS.
1890	Reid, M. M	Atlantic & Danville	Lawrenceville, Va.
1883	Renshaw, W	Illinois Central	Chicago, Ill.
1892	Rettew, C. E	D. & H. C	Carbondale, Pa.
1896	Reynolds, O. H	Central R. R. of N. J.	Jersey City, N. J.
1887	Rhodes, G. W	Burlington & Mo. River	Lincoln, Neb.
1899	Rhodes, L B	Ga. Southern & Fla	Macon, Ga.
1896	Richards, George F	Elmira, Cort. & Noth'n	Cortland, N. Y.
1897	Rickert, Mason	C. C. C. & St. L	Delaware, Ohio.
1894	Riley, George N	McKeesport Connecting	McKeesport, Pa.
1899	Risteen, F. N	Northern Pacific	Fargo, N. D.
1882	Roberts, E. M	White & Black Riv. Val.	Brinkley, Ark.
1896	Roberts, J. W	1124 Cornell ave.,	Indianapolis, Ind.
1891	Roberts, Mord	St. L. I. M. & S	De Soto, Mo.
1895	Robinson, Frank	Maine Central	Bangor, Maine.
1898	Robinson, J. T	Southern R'y	Selma, Ala.
1896	Robkin, Charles	Little Rock & Mem	Argenta, Ark.
1896	Rogers, M. J	K. C. Belt	Kansas City, Mo.
1898	Romans, G. L	Coast R'y	Yarmouth, N. S., Canada.
1896	Rosing, W. H. V	Illinois Central	Chicago, Ill.
1894	Roth, Frederick		Hazelton, Pa.
1891	Rotheram, T. F	New Zealand Govt	Wellington, N. Z.
1895	Royal, C. B	Seaboard Air Line	Portsmouth, Va.
1898	Rumney, T	Ogdensburg & Lake Champlain,	Malone, N. Y.
1896	Rusch, Peter C	Buffalo, Roch. & Pitts.	Bradford, Pa.
1893	Ryan, E	Gal. H. & San Ant	San Antonio, Tex.
1892	Ryan, Patrick	Louisville & Nashville	Russellville, Ky.
1891	Ryan, J. J	Southern Pacific	Houston, Tex.
1891	Ryder, Henry	Housatonic	Falls Village, Conn.
1892	Sague, J. E	Schenectady Loco. Works,	Schenectady, N. Y.
1887	Sample, N. W	Denver & Rio Grande	Denver, Colo.
1891	Sanborn, J. N	Brainard & No. Minn.	Brainard, Minn.
1896	Sanderson, R. P. C	Norfolk & Western	Roanoke, Va.
1895	Sandt, E. I	Phila. & Reading	Philadelphia, Pa.
1896	Sanford, J. W	Pennsylvania	Jersey City, N. J.
1896	Santer A	Norfolk & Western	Lambert's Point, Va.
1898	Schaefer, Hugo	Phila. Reading & New	England, Hartford, Conn.
1874	Schlacks, Henry	Denver & Rio Grande	Denver, Colo.
1875	Sedgwick, E. V	Galena Oil Co	Franklin, Pa.
1896	Sehrt, H. M	Ohio Southern	Springfield, Ohio.
1869	Setchel, J. H		Cuba, N. Y.
1868	Shaver, D. O	Pennsylvania	Pittsburg, Pa.
1891	Sheer, Jas M	514 Seventh st.,	East St. Louis, Ill.
1899	Shepard, L. A	Phila. & Reading	Reading, Pa.
1898	Shields, Alex	Southern Indiana	Bedford, Ind.
1890	Shields, J. C	Mineral Range	Hancock, Mich.

JOINED.	NAME.	ROAD.	ADDRESS.
1898	Shone, G. H	Denver & Rio Grande	Alamosa, Colo.
1883	Sinclair, Angus		95 Liberty st., New York City.
1892	Sinnott, B	Balto. & Ohio	Philadelphia, Pa.
1896	Skinner, Calvin	Toledo, St. L. & K. C	Frankfort, Ind.
1889	Skinner, H. M. C		88 Walnut st., Fall River, Mass.
1893	Slater, Frank	Chicago & N.-W	Escanaba, Mich.
1889	Slater, John C	Nevada Cent	Battle Mt., Nev.
1894	Slayton, C. E	Chic. Gr. Western	Dubuque, Iowa.
1889	Small, H. J	Southern Pacific	Sacramento, Cal.
1893	Smith, F. B	N. Y. N. H. & H	New Haven, Conn.
1896	Smith, F. C	Fitchburg	Keene, N. H.
1890	Smith, Geo. W	Santa Fe Pacific	Albuquerque, N. M.
1894	Smith, H. C		117A North Olive st., Los Angeles, Cal.
1892	Smith, John L	Buffalo, Roch. & Pitts	Du Bois, Pa.
1899	Smith, R. D	Chgo. Bur. & Quincy	Chicago, Ill.
1891	Smith, Wm	Duluth, Missabe & Nor.	Duluth, Minn.
1869	Smith, W. T	Chesapeake & Ohio	Covington, Ky.
1891	Soule, R. H	Baldwin Loco. Wks., 1217 Monadnock Bldg.,	Chicago, Ill.
1897	Spragge, Jos. R	Can. Pacific	McAdam Junct., N. B.
1868	Sprague, H. N		Jamestown, N. Y.
1895	Sprigg, Z. T	Union Pacific	Denver, Colo.
1890	Stamelen, F	Erie & Huron	Chatham, Ont.
1898	Stansbury, C. M	Pecos Vall. & N.-East	Roswell, N. M.
1894	Steele, S. A	W. & Pitts	Weston, W. Va.
1899	Stevens, F. H	Brooks Loco. Wks.	Dunkirk, N. Y.
1874	Stevens, Geo. W		Cleveland, Ohio.
1892	Stewart, Andrew F	Ches. & Ohio	Huntington, W. Va.
1885	Stewart, O	Bangor & Aroostook	Oldtown, Maine.
1890	Stillman, H	Southern Pacific	Sacramento, Cal.
1896	Stocks, W. H	C. R. I. & P	Chicago, Ill.
1883	Stokes, J. W	O. K. C. & E. and O. & St. L.,	Stanberry, Mo.
1896	Stout, S. E	Phila. & Reading	Philadelphia, Pa.
1875	Strode, Jas	Northern Central	Elmira, N. Y.
1890	Studer, A. L	C. R. I. & P	Horton, Kan.
1892	Sumner, Eben T	Boston & Maine	East Cambridge, Mass.
1892	Sutherland, R. D	Boston, R. B. & Lynn	Boston, Mass.
1868	Swanston, Wm	P. C. C. & St. L	Indianapolis, Ind.
1899	Symington, T. H	Atlantic Coast Line	Wilmington, N. C.
1892	Symons, W. E	Plant System	Savannah, Ga.
1894	Taft, Wm. H	Boston & Albany	Boston, Mass.
1883	Tandy, H	Supt. Canadian Loco. Works,	Kingston, Ont. Can.
1896	Tawse, Robt	Ann Arbor	Owosso, Mich.
1893	Taylor, C. M	A. T. & S. F	Raton, N. M.
1896	Taylor, Jno	C. M. & St. P	Minneapolis, Minn.
1893	Taylor, Wm. H	Wilkesbarre & East	Stroudsburg, Pa.

JOINED.	NAME.	ROAD.	ADDRESS.
1886	Thatcher, Thos	D. L. & W	Utica, N. Y.
1885	Thomas, C. F	Southern	Alexandria, Va.
1891	Thomas, H. T	Det. & Mackinac	East Tawas, Mich.
1892	Thomas, J. J., Jr	Mobile & Ohio	Tuscaloosa, Ala.
1883	Thomas, W. H	Southern	Washington, D. C.
1890	Thompson, C. A		Jersey City, N. J.
1896	Thompson, Geo	N. Y. Cent. & Hud. Riv.	Corning, N. Y.
1895	Thompson, W. F	Kings Co. Elev	Brooklyn, N. Y.
1883	Thow, Wm	Government	Sydney, N. S. W.
1892	Todd, Louis C	Boston & Maine	Lyndonville, Vt.
1898	Tollerton, W. J	Oregon Short Line	Salt Lake City, Utah.
1897	Tomlinson, J. J	Mex. Northern	Escalon, Chihuahua, Mex.
1893	Tonge, John	Minn. & St. Louis	Minneapolis, Minn.
1896	Tower, G. M	Fitchburg	Fitchburg, Mass.
1892	Townsend, Jos	Chic. & Alton	Bloomington, Ill.
1896	Tracy, W. L	Southern	Atlanta, Ga.
1892	Traver, W. H	Rand Drill Co.,	Monadnock Block, Chicago, Ill.
1883	Tregelles, Henry	Care Norton, Megaw & Co.,	Rio de Janeiro, Brazil.
1892	Tremp, A. E	C. C. C. & St. L	Indianapolis, Ind.
1892	Tresize, Thos		1523 West Lanvale st., Baltimore, Md.
1896	Tubbs, F. E		1018 W. Duval st., Jacksonville, Fla.
1890	Tuggle, S. R	Houston & Tex. Cent.	Houston, Tex.
1890	Turner, Calvin G	Phil. Wil. & Balto	Wilmington, Del.
1889	Turner, Chas. E	B. R. & P	Rochester, N. Y.
1886	Turner, J. S	Fitchburg	Boston, Mass.
1890	Turner, L. H	Pitts. & L. Erie	McKees Rocks, Pa.
1886	Twombly, A. W	Old Colony	Taunton, Mass.
1883	Twombly, Fred M	N. Y. N. H. & H	Boston, Mass.
1899	Tynan, F. F	Ferro Carrel de Matanzas,	Matanzas, Cuba.
1890	Tyrrell, Thos. H	Staten I. Rap. Transit.	Whitehall st., N. Y. City.
1889	Vail, A	Western N. Y. & Pa	Buffalo, N. Y.
1898	Van Alstine, D	Chic. Great Western	St. Paul, Minn.
1890	Van Brunt, G. E	Penna. & N.-Western.	Bellwood, Pa.
1896	Van Cleve, J. R	Great Northern	Kalispell, Mont.
1891	Vauclain, Samuel M	Baldwin Loco. Works,	Philadelphia, Pa.
1898	Vaughan, H. H	Q. & C. Co	Chicago, Ill.
1896	Villasenor, Alberto	Ferro Carrel Central del Salvador,	La Union, Salvador, C. A.
1892	Vogt, A. S	Pennsylvania	Altoona, Pa.
1892	Wade, R. D	Baldwin Loco. Wks,	Washington, D. C.
1892	Waitt, A. M	N. Y. Central & Hudson River,	New York, N. Y.
1893	Walker, Henry E	Mexican Southern	Pueblo, Mex.
1891	Wallis, J. M	Pennsylvania	Williamsport, Pa.
1888	Wallis, Philip	Long Island	Long Island City, N. Y.

JOINED.	NAME.	ROAD.	ADDRESS.
1874	Walsh, Thos	Louisville & Nashville	Howell, Ind.
1896	Walton, E. A		Tamaqua, Pa.
1896	Ward, C. A	Bangor & Portland	Bangor, Pa.
1887	Ward, C. F	Duluth, Superior & West.	Cloquet, Minn.
1883	Warren, Beriah	T. P. & W	Peoria, Ill.
1882	Warren, W. B	T. P. & W	Peoria, Ill.
1883	Watts, Amos H	Cincinnati Northern	Van Wert, Ohio.
1896	Waugh, L. H	G. C. & S. F	Cleburne, Tex.
1887	Webb, F. W	London & North West	Crewe, England.
1892	Weiss, C. P	Erie	Hornellsville, N. Y.
1886	Weisgerber, E. L	Balt. & Ohio	Mt. Clare Shops, Baltimore, Md.
1868	Wells, Reuben		Rogers Loco. Works, Paterson, N. J.
1896	West, A. T	Tabor & Northern	Tabor, Iowa.
1880	West, G. W	N. Y. O. & W	Middletown, N. Y.
1899	Westmark, H. O	Chi. & North-Western	Chicago, Ill.
1885	White, A. M		Schenectady Loco. Works, Schenectady, N. Y.
1894	White, E. T	Balto. & Ohio	Mt. Clare, Baltimore, Md.
1898	Whyte, F. M	N. Y. Cent. & Hudson River	New York.
1899	Wiest, E. N	Man. & North-Eastern	Manistee, Mich.
1894	Wiggin, Chas. H	Boston & Maine	Concord, N. H.
1884	Wightman, D. A		Pitts. Loco. Works, Allegheny, Pa.
1891	Wilcox, W. J	O. R. & S. C	Blacksburg, S. C.
1896	Williams, Alfred	Paulista	Paulista, Brazil, S. A.
1891	Williams, E. A	M. St. P. & S. S. M	Minneapolis, Minn.
1887	Wilson, G. F	C. R. I. & P	Chicago, Ill.
1898	Witmer, J. W	Detroit, Toledo & Milwaukee	Marshall, Mich.
1896	Yohn, C. R	H. & B. T. Mtn	Saxton, Pa.
1895	Young, W. H	Florida So	Sanford, Fla.
1898	Zerbee, F. J	C. C. C. & St. L	Wabash, Ind.

ASSOCIATE MEMBERS.

JOINED.	NAME.	ADDRESS.
1893	Baker, Geo. H	Metropolitan Bldg., New York City.
1898	Basford, G. M	Morse Bldg., New York City.
1898	Bates, E. C	Crosby Steam Gauge & Valve Co., Boston, Mass.
1890	Crossman, W. D	Manhattan Bldg., Chicago, Ill.
1883	Dean, F. W	55 State street, Boston, Mass.
1896	Fowler, Geo. L	53 Broadway, New York City.
1880	Gordon, Alex	Niles Tool Works, Hamilton, Ohio.
1895	Goss, W. F. M	Purdue University, Lafayette, Ind.
1889	Hill, John A	256 Broadway, New York City.
1899	Kneass, Strickland L	Wm. Sellers Co., Ltd., Philadelphia, Pa.
1871	Miles, F. B	Bement & Miles, Philadelphia, Pa.
1897	Moore, E. F	Railroad Commission, Lansing, Mich.
1889	Pomeroy, L. R	71 Broadway, New York City.
1893	Robinson, Harry P	Monadnock Bldg., Chicago, Ill.
1886	Shaw, Thos	915 Ridge street, Philadelphia, Pa.
1899	Smart, R. A	Purdue University, Lafayette, Ind.
1889	Smith, John Y	Doylestown, Pa.
1882	Smith, W. A	Old Colony Bldg., Chicago, Ill.
1899	Street, Clement F	Dayton, Ohio.
1871	Wheelock, Jerome	98 Eastern ave, Worcester, Mass.

HONORARY MEMBERS.

JOINED.	NAME.	ROAD.	ADDRESS.
1869	Coolidge, G. A		Charlestown, Mass.
1870	Cooper, H. L.		4644 State street, Chicago, Ill.
1895	Coster, E. L.	Assistant in Mechanical Engineering Columbia University, Residence, Irvington.	27 William st., New York City.
1870	Divine, J. F	W. & Weldon	Wilmington, N. C.
1881	Eastman, A. G.		Sutton, Que.
1871	Forney, M. N		501 Fifth avenue, New York City.
1872	Foss, J. M.	Cent. Vermont	St. Albans, Vt.
1885	Galloway, A.	C. H. & I.	Indianapolis, Ind.
1869	Graham, Chas.		401 Madison Avenue, Scranton, Pa.
1870	Hodgman, S. A.	Lobdell Car Wheel Works,	Wilmington, Del.
1874	Jeffery, E. T	Denver & Rio Grande.	Denver, Colo.
1868	Johann, Jacob.		1003 South Seventh street, Springfield, Ill.
1868	Kinsey, J. I.	Lehigh Valley	Easton, Pa.
1893	Leeds, John H.		318 Howard ave., New Haven, Conn.
1878	Maglenn, Jas	Seaboard Air Line.	Raleigh, N. C.
1891	McKenna, John	I. D. & S. W	Indianapolis, Ind.
1872	Philbric, J. W		Waterville, Maine.
1873	Prescott, G. H		Logansport, Ind.
1869	Richards, George.		14 Auburn street, Roxbury, Mass.
1870	Robinson, W. A.		Hamilton, Ont.
1869	Sellers, Morris		Western Union Bldg., Chicago, Ill.
1888	Sheppard, F. L	Pennsylvania.	Altoona, Pa.
1883	Sullivan, A. W.	Ill. Cent.	Chicago, Ill.
1869	Thompson, John		137 Webster street, East Boston, Mass.
1870	Towne, H. A.		236 First avenue, Minneapolis, Minn.
1870	Williams, E. H		Baldwin Loco. Works, Philadelphia, Pa.

PROCEEDINGS.

The Thirty-second Annual Convention of the American Railway Master Mechanics' Association was called to order at 10:10 A.M., on Monday, June 19, 1899, in the ballroom of the Hotel Chamberlin, Old Point Comfort, Virginia, by President Robert Quayle.

The following members were present:

Aldcorn, T.
Allen, G. S.
Arp, W. C.
Atkinson, R.
Barnett, J. D.
Barr, J. N.
Basford, G. M.
Bates, E. C.
Battye, J. E.
Bean, J.
Beltz, A. J.
Blackall, R. C.
Boon, James M.
Bowles, C. K.
Branch, G. E.
Brooke, G. D.
Bronner, E. D.
Brown, D.
Brown, W. A.
Browne, T. R.
Bryan, H. S.
Bushnell, R. W.
Christie, W. K.
Christopher, J.
Clark, F. H.
Clark, I. W.
Cockfield, J.
Cole, F. J.
Cook, J. S.
Cooper, D. S.
Cory, C. H.
Crossman, W. D.
Cunningham, J.
Cushing, G. W.
Dallas, W. C.
Davis, E. E.
Davis, M. R.
Delano, F. A.
Dickerson, S. K.
Dolan, S. M.
Downing, T. M.
Drury, M. J.
Dunn, J. F.
Ellis, J.
Ennis, W. C.
Feely, T. M.
Fowler, G. L.
Gaines, F. F.
Galbraith, R. M.
Gardner, A.
Garstang, W.
Gentry, T. W.
Gibbs, A. W.
Givin, F. A.
Gordon, H. D.
Griffith, F. B.
Hanglin, J. A.
Haskell, B.
Hassman, W.
Hatswell, T. J.
Hatswell, T. J., Jr.
Hawksworth, D.
Hedley, F.
Henderson, G. R.
Hibbard, H. Wade.
Hickey, John.
Higgins, S.
Hill, J. A.
Hill, R.
Hoffman, R. F.
Holman, W. L.
Homer, J. C.
Hudson, E E.
Hudson, H. G.
Hudson, W. H.
Hufsmith, F.
Humphrey, A. L.
Hyndman, F. T.
Jackson, O. H.
Johann, J.
Johnson, R. H.
Joughins, G. R.
Keegan, J. E.
King, D. M.
Kneass, S. L.
Lake, E. M.
La Lime, E.
Lang, V. B.
Lawes, T. A.
Lawrence, J. L.

Leach, H. L.	Peck, P. H.	Sinclair, A.
Lewis, W. H.	Pflager, H. M.	Slater, F.
Losey, J.	Pilsbury, A.	Small, H. J.
Machesney, A. G.	Pomeroy, L. R.	Smith, R. D.
Mackenzie, J.	Quayle, R.	Smith, W. T.
Manchester, A. E.	Quereau, C. H.	Soule, R. H.
Marshall, E. S.	Quinn, J. A.	Stewart, A. F.
McIntosh, William.	Reid, M. M.	Stewart, O.
McLean, W. J.	Reynolds, O. H.	Stout, S. E.
McNaughton, J.	Riley, G. N.	Swanston, W.
Mellin, C. J.	Risteen, F. N.	Symons, W. E.
Michael, J. B.	Roberts, E. M.	Thomas, W. H.
Miller, G. A.	Roberts, M.	Tonge, J.
Miller, R.	Robinson, H. P.	Tower, G. M.
Mitchell, A. E.	Royal, C. B.	Traver, W. H.
Morris, W. S.	Rumney, T.	Tuggle, S. R.
Neuffer, J. G.	Sague, J. E.	Turner, C. G.
Noble, L. C.	Sanderson, R. P. C.	Tyrrell, T. H.
Norsworthy, N. W.	Sauter, A.	Watts, A. H.
Nuttall, W. H.	Schafer, H.	West, G. W.
O'Brien, J.	Sehrt, H. M.	Whyte, F. M.
Owens, W. H.	Shepard, L. A.	Zerbee, F. J.

THE PRESIDENT: The convention will please come to order. Ladies and gentlemen, I think that we are peculiarly fortunate this morning in having with us the Rev. Charles S. Walke, Post Chaplain of the United States Army. He will offer the invocation. While he does so, I would be glad to have every one in the room rise. Let us now stand.

Prayer was then offered by the Rev. Charles S. Walke.

THE PRESIDENT: It is customary for us to have some one address this meeting, and I might say that I am indebted to our vice-president, Mr. W. S. Morris, not only for his co-operation but for his very earnest, active work in securing the services of one who is capable and peculiarly fitted to deliver an address to us. We have with us this morning the Hon. Joseph Bryan, a native of Virginia, who is president of the Richmond Locomotive Works. He will now address the convention. The Hon. Mr. Bryan. (Applause.)

MR. BRYAN delivered the following address:

MR. PRESIDENT, AND GENTLEMEN OF THE MASTER MECHANICS' ASSOCIATION,—I must at once express my high appreciation of the honor that has been done me by this Association in inviting me to appear before you. To appropriate even a short space of your valuable time to listening to anything that I may have to say is a

compliment far beyond my merits, but not greater than my appreciation of the honor. I have no claim to and make no pretense to have any professional qualification for participating in the scientific and practical part of your deliberations, and I am aware that the intrusion of one who can not contribute to the accumulations of your knowledge is not regarded favorably. I have from high authority the statement that "scientific congresses are meetings of experienced men, whose object is to fight out subjects of consequence, but that these words have sometimes lost their meaning, owing to the fact that at certain scientific congresses laymen have often crept in, attracted by the entertainment provided for the experts." I trust that this layman may not become presumptuous, by reason of the unmerited compliment which he has received.

While I have no commission which can justify me in speaking a word of welcome to you in behalf of our people, yet as a Virginian, to the manner born, I know I express their sentiments when I say it is with both pleasure and pride that we see your Association assembled within our borders, and at a place the very first on this side Cape Henry which was visited by the founders of our Anglo-Saxon civilization on this hemisphere. After the storm-tossed vessels had reached this safe and serene harbor they called this spot Point Comfort, and Point Comfort it has been ever since.

It is indeed most gratifying to see you here, and it augurs well for the long-delayed industrial development of Virginia to have such a congregation of mechanical experts on her shores. We Virginians have lost much valuable time. Our so-called ante-bellum domestic institutions did not tend to promote, if they were not actually inconsistent with, industrial enterprises. Especially were the benefits of a transatlantic railroad long deferred because, under the advice of George Washington, the State had pledged her resources to the construction of the James River and the Kanawha Canal for the purpose of uniting the waters of the Ohio River with those of the Chesapeake Bay, and although as early as 1837, when many millions had been spent on the canal and when railroading was an infant crawling on the floor, or rather squalling in its cradle, Cladius Crozet, a French engineer, who, by the way, served under the great Napoleon in his fateful Russian campaign, then denounced the canal as a failure and predicted that a railroad would take its place. This prophecy was not fulfilled for nearly fifty years — but what a succession of lost opportunities were crowded in that period!

How much will the Chesapeake & Ohio and all its Master Mechanics have to do to catch up with those whose labor and capital were not so misdirected?

But, gentlemen, without pausing to shed Virginian tears over lost opportunities, let us consider for a moment the salient features of the work you and your predecessors have accomplished and express a hope as to that which may be done.

This is especially an age of combination. Individualism must pay its tribute to collectivism, and that the tribute may be at once levied and received the members of every sphere of human activity are found working together for their common good. I have thought that this development was peculiarly great in the United States, where associations of every kind — religious, political, benevolent and scientific — which are being constantly held in different parts of the Union, have brought people from each section into close touch with those of other sections, and in their conferences

errors have been corrected, friendships cemented, truths illustrated, and much done to fashion the people of these United States into one happy and harmonious whole. This practice is unquestionably a most beneficent means of improving the condition of the whole country, and making us indeed brothers of one great commonwealth extending from ocean to ocean. As to what has been done in Europe in connection with the development of the science of railroading in all of its branches, your own included, through the medium of the International Railroad Congress, I am indebted for information and documents on this subject to Mr. Victor Kleming, Superintendent of Motive Power of the Swedish State Railway; to Mr. Theodore N. Ely, Chief of the Motive Power of the Pennsylvania Railroad, and to Major E. T. D. Myers, President of the R. F. & P. R. R. The first two of these gentlemen have been active participants in this great International Congress, whose purpose is to include every branch of railroad management, and to admit to its counsels the representatives of railroads from every part of the world.

The first association of this great organization was held in Brussels in 1885 in connection with the celebration of the half-centennial of Belgium railways. To this congress the Belgium Government invited the governments of other States to send representatives from their railways, and it was understood that the aim of the congress was to be only to bring together railway men from different countries to discuss questions of general interest to railways, but not to pass any resolutions of a binding nature. They provided, however, for another session of the congress, which was held in Milan in 1887. A small sum was levied as an initiation fee, and then in proportion to the mileage represented, for the privilege of participating in these congresses and for receiving its reports. The plan adopted was to divide the whole realm of railroad business into sections and subsections, upon which special committees were appointed, and every department was thoroughly covered. Succeeding congresses were held in Paris in 1889, in St. Petersburg in 1892, and the last was in London in 1895. The next will be held in Paris during the coming Exposition of 1900.

I have had before me large volumes reporting the sessions of this congress in London, where nearly every nation in the world where there is a railroad was represented. Forty-one members represented the United States, besides the nine representatives of the American Railway Association. Only sixteen railroads, however, had their special representatives, and of them only two were marked as Superintendents of Motive Power — Mr. Theodore N. Ely, of the Pennsylvania Railroad, and Mr. James Cullen, of the Nashville, Chattanooga & St. Louis. A very large volume is devoted almost exclusively to the question of locomotives and rolling stock. When we reflect that the United States alone has more than two-fifths of the railroad mileage of the whole world, and with 36,000 locomotives adapted to every conceivable condition of traffic, it may well be believed that the combined experience of this country will be quite an offset for that of the rest of mankind. It does not require an international congress with its babel of tongues for this association of Master Mechanics to approach with confidence, and with the aid of science and in the light of experience solve, any problem in locomotive mechanism, however difficult.

Such an organization as yours, gentlemen, has in its particular department not its equal on earth.

The extraordinary development of railroads is the greatest phenomenon of the nineteenth century. When we reflect that in the first years of this century traffic was done substantially in the same manner as it had been done for thousands of years before, and that the Roman roads, which that conquering nation in their triumphant progress had constructed throughout Europe, still remained models of solidity and types of the progress of their civilization; when we reflect how the comfort and happiness of mankind is bound up in the facility of interchange of goods and transportation of passengers, we may well regard the century in which we live as one that has been illuminated with a sunburst of blessings in the development of railroads. Nor should it be forgotten that for more than twenty years railroads themselves had been operated before the use of a locomotive of any kind — that is, vehicles had been pulled upon rails with horses — but the idea of the locomotive was regarded as nothing but a mere chimera of a disordered imagination. In 1820 a Mr. Thomas Gray published a work in which he propounded a general iron railway or land steam conveyance to supersede the necessity of horses in all public conveyances. Despite all of his arguments, and the present necessity for some better means of communication, the wiseacres of that day listened to Mr. Gray with a smile akin to pity, and dismissed him as an incorrigible visionary. While Mr. Gray lived to see Stephenson's Rocket, yet he died "steeped to the lips in poverty."

Macaulay, in reviewing this situation, said: "There were fools then, as there are fools now. Fools who laughed at the railroad as they had laughed at canals. Fools who thought that they evinced their wisdom by doubting what they could not understand." When the railroad between Liverpool and Manchester was chartered, it was with the idea that the vehicles would be drawn by horse power. This was soon determined to be inadequate for the business which promised, and so the choice lay between the yet undiscovered locomotive, which until then had its existence only in the imagination of men who were believed to be half crazy, and of stationary engines by which the cars would be dragged by ropes turned over a drum. In order to bring some conclusion to this matter a premium of £500 was offered by the company for the best locomotive that could under certain stipulations be constructed; but it was promised that the successful competitor should have the construction of the whole "stud" of locomotives required by the railway, still applying the language of the stable and the stage coach to the operations of the railway. The company required that if an engine weighed six tons it should be capable of drawing a train of twenty tons, including the tender, at a speed of ten miles an hour on a level railway, and that each locomotive should have two safety valves, one beyond the control of the engine driver, and that their height, including the chimney, should not exceed fifteen feet. This specification was received with ridicule by the most eminent engineers of the day. One of them said, "It is far from my wish to promulgate to the world that the ridiculous expectations, or rather professions, of the enthusiastic speculatist, will be realized, and that we shall see engines traveling at the rate of twelve, sixteen, eighteen and twenty miles an hour. Nothing can do more harm towards their general adoption and improvement than the promulgation of such nonsense."

"As to those persons," said the *Quarterly Review*, "who speculate on making railways generally throughout the kingdom, and superseding all the canals, all the

wagons, mails and stage coaches, post chaises, and, in short, every other mode of conveyance, by land and by water, we deem them and their visionary schemes as unworthy of notice. The gross exaggerations of the powers of the locomotive steam engine may delude for a time, but must end in the mortification of those concerned. What, for instance, can be more palpably absurd and ridiculous than the following paragraph, in one of the published proposals of what we should call a 'hopeless project'?" The scheme here alluded to was of laying down a railway between the Metropolis and Woolwich, in which it was considered that "twice the velocity" of the coaches might be attained, combined with "greater safety." The anticipation that, by the agency of steam, travelers would some day proceed "at the rate of four hundred miles a day, with all the ease we now enjoy in a steamboat, but without the annoyance of seasickness, or the danger of being burnt or drowned," called forth the indignation of the reviewer. "But with all these assurances," he adds, "we should as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's ricochet rockets as trust themselves to the mercy of such a machine going at such a rate."

It was no doubt the sting of this ignorant ridicule which incited Stephenson, in brave defiance of his cavilers, to call his first locomotive the "Rocket"!

You are all aware that in the trial of the locomotives that followed the reward offered by the Liverpool & Manchester Railroad, Stephenson's locomotive, the Rocket, was the successful competitor. You have all either seen the facsimile of this machine or accurate descriptions of it. I need not say to you that between Stephenson's Rocket and the modern first-class passenger or freight locomotive there is as much difference as there was between Pharaoh's chariots and the English stage coach, and yet thousands of years elapsed between the chariot and the stage coach, while barely sixty elapsed between the Rocket and the results of your own designs. One of the most gratifying incidents to our American experience in the construction of locomotives is the rapid progress that is made in their acceptance by foreign railways. I think that within the past year there has been the greatest progress in this respect that has ever taken place. While in the review of the reports of the International Railway Congress, made by its president, M. Dubois, as late as November 25, 1894, he reported that "Locomotives with external cylinders must be given up, for running at great speed, the shocks they produce increasing with speed, owing to the action of the centrifugal forces due to the counter weights."

With this condemnation of external cylinders yet fresh in their memory we have seen the American locomotive find its way not only into many continental countries of Europe but into the very heart of England. It is only this month that the administration of the Egyptian Railways has asked for American designed locomotives for both freight and passenger service. The same is true of the Finland State Railways and of Swedish State Railways who have also asked for American designs. These instances in addition no doubt to many others have occurred within the last few weeks, and is largely due not merely to the superiority of the American locomotive, but to the fact that it can be built with greater facility and at much less cost than the English or continental designs. You gentlemen will recall that a great shock was given to the English mechanical world by the fact that the Atbara Bridge, which was to cross the river of that name, in the construction of the Cape to Cairo

line, was due to the fact that the American bridge builder had his design prepared and the material ready, and in an incredibly short time the Pencoyd Iron Company put the bridge on shipboard after receipt of the order. Another shock was given when the Goktiek viaduct, ordered by the Burmah Railways, was taken by an American firm from five English firms at the price of £60,125 against £116,000, and with one year for construction against three years. The English have not yet been able to explain to their satisfaction why they were beaten upon the bridge business, and think that either there was some collusion in giving the contract, or that the Americans would be obliged to break down in their undertaking.

But in regard to locomotives, a recent English paper reports from a well-informed correspondent that "it does not take a mechanical expert to tell that on the English roads two locomotives are frequently employed to haul a load that one American engine could easily handle. That the order for American locomotives is essentially an experiment, but if it proves satisfactory there is no doubt that the business in American-built locomotives for English roads will largely increase." This declaration, which is sustained by facts of common knowledge, has worried not a little the English mechanical engineers and locomotive builders, and they have been obliged to find some explanation of it. The explanation they have hit upon is so singular that no one but an English genius would ever have thought of it. A trade paper called *Commercial Intelligence*, and a very interesting paper, explains it in this way as reported in the New York *Times*:

"To begin with, the English writer admits that the American engines are much cheaper than those of English make, that they are built much more quickly than English manufacturers have been accustomed to build them, and that they are just as good in all respects and better in a few.

"The American engine builder, declares *Commercial Intelligence*, works rapidly, cheaply and well because he is not hampered by the multitude of special restrictions that English railway managers are accustomed to place upon the English designer. In other words, the manager sends to America for an engine of such and such size and power. At home he insists upon boiler tubes of this make, injectors of that, and in a multitude of details lays down requirements that must be met.

"It will be seen," the article proceeds, "that the British locomotive engineer can not under such conditions adapt standard types of engines, or stock parts to facilitate ready construction, or specialize machine tools. Contrast this position with that of his American confrère. Railway engineers in the United States are not so particular. They are content to leave the designing to the locomotive builder and practically take what, within certain reasonable limits, is given them. The builder is consequently free to arrange his standard types, stock standard parts, and specialize machine tools for his standard parts."

Think of that, will you! Think of that, O you master mechanics, who cudgel your brains to find new designs and who for ten years have been changing your types of engines so rapidly as to make the poor manufacturer's head swim. Fancy locomotive shops with all sorts of parts constructed and put upon the shelves ready to be taken down and put together at a moment's notice to meet the simple and uniform, requirements of the Superintendents of Motive Power. It sounds like a roaring farce, but the same paper, not content with this, in a succeeding issue calls the loss of

this business to England "A blessing in disguise," and says: "There is, we think, every prospect that much good may result from the large amount of attention which has been directed to the recent orders for locomotives which have gone to America. At least, we hope it may mean a death-blow to fancy specifications. When the Midland Company and others have got their American *standard engines*, and found them to work satisfactorily, it is quite possible they may begin to realize that American railway practice is based on common sense, and our locomotive builders will not be made to suffer as they have been in the past. When Mr. I. Level, M. I. C. E., of the Heavy Rate Railway, finds that an American locomotive, made to a standard pattern, does as good or better work than his own specially designed 'faddy' engine, he may in future give our locomotive builders a chance to adopt standard types, not the least advantage of which is the ease with which they can be repaired and their standard parts replaced."

Seeing now what the English consider the ideal condition of locomotive building, is it unreasonable to hope that when we have progressed, as we have so rapidly done in the last ten years, up to the limits of bridges and rails and tunnels, that the genius of our master mechanics may be so directed as either to eliminate or generally adopt many of the excellent but novel designs which they have incorporated in their locomotives, and to reduce to something of a standard the locomotives which will be used for the various established services. What a comfort it would be to the builder to know that there was at least a reasonable chance of his having to build something that he had seen or heard of before. What an avoidance of useless expense and the assurance of better deliveries.

Gentlemen, should you at this meeting lay the foundation for the ultimate accomplishment of some standards in locomotive building as you have in other parts of your mechanical sphere, you would indeed have begun to inaugurate the millennium in your business, and the last year of this century would promise results which would be a fit climax to all the wonderful achievements that have gone before.

I have kept you too long and I owe you an apology for it, but the subject is interesting, the audience most intelligent and attentive, and the opportunity too good to be lost to put in a word for this great reformation. I thank you for your attention, and I trust that it may be said that Old Point Comfort has been the scene of at least the beginning of one of the greatest achievements in the practice of locomotive building ever accomplished by the Association of Master Mechanics.

THE PRESIDENT: I am now to introduce to you a gentleman who is known by this body to be a very modest man — a capable man, however. I have asked him to respond in a short address to the address just listened to. We will now hear Mr. W. S. Morris, Superintendent of Motive Power of the Chesapeake & Ohio Railway. (Applause.)

MR. MORRIS: Mr. President, ladies and gentlemen,— The President has detailed one of his lieutenants to perform a duty which, in a measure, I am responsible for, in having Mr. Bryan with us this morning. My efforts will be feeble in any attempt to express the thanks of

this Association after hearing the gentleman's able address to us. The history of the locomotive is a never-failing subject of interest, and as members of that Association which is especially charged with the construction and improvement of locomotives, we may all take a just pride in what has been accomplished. In one sense we could wish that we had reached the end of our labors of experiment and improvement, and could rest upon what has been so well developed. But however satisfactory our standard types of locomotive may be, I can not hold out to Mr. Bryan or any other manufacturer a reasonable hope that changes will not continue until the end of the chapter. The remarkable changes that have been made within the last ten years in both the increase of weight and steam pressure, do not indicate that we have yet reached the limit of locomotive capacity, and it seems to me that in America will be the field for the most successful improvements of the locomotive, and for making experiments that nowhere else would be dared. I would say, however, for the encouragement of our friend, Mr. Bryan, that I believe we have now standard types of locomotives for the different services which might properly be approved and substantially adopted and fill all requirements for some time to come.

We fully sympathize with the desire of Superintendents of Motive Power and Master Mechanics to design a locomotive a little better than anybody else, but we are aware that that ambition tends to lead to almost capricious changes, and involves expense that might reasonably be avoided. While no standard types, according to the English idea, as narrated by Mr. Bryan, are in sight, something may be done to limit the number of variations which have no substantial benefit in them. In this respect I believe that a closer relationship between the motive power men and the builders would be a benefit to both sides, and I hope that the locomotive builders will be gratified to know that something has been done by us on this line.

Mr. Bryan, I have the honor to extend to you the hearty thanks and appreciation of the American Railway Master Mechanics' Association. Mr. President and gentlemen, it is but fitting that this expression by your representative should be indorsed, and I will, therefore, move you, sir, that our thanks be expressed to Mr. Bryan by a rising vote.

MR. MCCONNELL: I second the motion.

THE PRESIDENT: You have a motion that a rising vote be extended on behalf of this Association to the Hon. Joseph Bryan for the address given to us this morning. All in favor of that will please rise to their feet. Thank you. It is unanimous. Lest the announcement of the President's address might drive many from the room, I take this opportunity of asking the First Vice-President, Mr. McConnell, to make one or two important announcements.

MR. J. H. MCCONNELL: Ladies and Gentlemen,—It is always considered best not to give all the good things at once, and for that reason, I desire to say that we are going to have something good tomorrow. Captain Evans, otherwise known as "Fighting Bob" Evans, will address this convention tomorrow morning at 10 o'clock, and I would suggest to you that if you want to hear something good, don't stay away. (Applause.)

The Entertainment Committee announces that the Master Mechanics' ball will take place Tuesday evening at 9 o'clock sharp, in the ballroom of the Hotel Chamberlin. Officers and members of this convention are most urgently and respectfully requested to fall in in the grand march at that time.

A cake walk by the waiters of this hotel will take place tonight in this hotel, commencing at half-past eight. So you will see that we have got you pretty well filled up for today and tomorrow.

THE PRESIDENT: Ladies and Gentlemen,—I take this opportunity of expressing to Chaplain Walke our appreciation of his presence this morning, and to say that at the proper time a Committee on Resolutions will be appointed who will take care of that part of it. Now, if you will give me your attention, I have but little to say, and that little may not be of much value, but we will get through with it as quickly as possible.

PRESIDENT QUAYLE then read the following address:

We assemble for the third time at Old Point Comfort. It is appropriate that we should meet again this year among surroundings intimately associated with the beginnings of our country, especially because of the most satisfactory conclusion of that which has stirred the national feeling of all true Americans. It has shown that we are one people, ready to arise to any emergency, and prepared to accept the greatest responsibilities that destiny presents. As a professional body, we have the satisfaction of observing our usefulness, contributing to the celerity of the operations of the war. But for adequate transportation, in which our part is important, the destruction, the pain and the sorrow of the war would have been immeasurably greater. We can rejoice that the ammunition used by Dewey reached him three days before

his departure for his memorable victory, and we may properly congratulate ourselves in being factors in the world's development. We should think of this in the hours of our drudgery, and it should be an inspiration for the future.

It is with pleasure and pride that we recall the hearty words of welcome we received two years ago from Colonel Hasbrouck, and it is a privilege to say that the insight we obtained at that time into the heavy artillery of our army was recalled with satisfying assurance in the days before we learned that the Spaniards could not hit anything but water. Our gratitude to those officers is deep; we know what they have done and what they will do, and we are proud of them, for today the work of our naval officers stands second to none.

The return of good times finds the affairs of our Association in a satisfactory condition. Our total membership is as follows: Active, 609; Associate, 18; Honorary, 26, a total of 653. This is the largest enrollment the Association has ever had. Our finances the records show to be equally pleasing, and we are reaping the rewards of the unusual efforts for economy of the past few years. During the past year the following deaths have occurred: Four Active members, as follows: Messrs. Frank Bruce, T. A. Fraser, J. R. Wagner and O. De Young; and three Honorary members, as follows: Messrs. Wilson Eddy, J. S. McCrum and J. L. White. We have the sad duty of recording their services and the pleasure of recalling their presence last year.

As Chiefs of Motive Power Departments we have many problems before us, and it may not be unprofitable to note the direction toward which the solution of some of them are drifting.

Since our last convention we have seen a very marked advance in the weight and power of locomotives, both passenger and freight, and this is most important. The problem in freight service is how to meet the reducing rates with economies that will secure the maximum net earnings. To do this more powerful locomotives are necessary, and yet the track must not be made to suffer; and this, I believe, may be accomplished. We may need to increase wheel loads somewhat, but by using larger driving wheels the counterbalance weight may be made even less destructive than small wheels with lighter loads. We ought to build engines that will haul at least 2,000 tons on grades of from $\frac{6}{10}$ to $\frac{7}{10}$ of one per cent, and instead of driving wheels of 55 inches for road engines, on lines with ruling grades less than one per cent we ought to use 60 inches. On such roads, by increasing train loads from 1,500 to 2,100 tons, we ought to save not less than half the cost of the heavier engine per year.

The greatest possibilities in saving, by the use of more powerful engines, are in the wages of engine and train crews. The expense of running a freight train for trips of about 100 miles at ten miles per hour, which is uniform, regardless of weight of train and the grades, is about $22. The cost of coal will be less per ton-mile for heavier trains, but it is this constant charge for crews which effects the saving when their number is reduced. The labor-cost at the roundhouse will be somewhat greater per engine-mile, but when compared on the basis of ton-miles it must be less, even when the labor of wiping is included. The wages of engine dispatchers are the same for heavy as for light engines, but since a smaller number are required for a given amount of work, this expense should be less than with those that are more powerful.

The saving in coal is next to that of labor, and within the proper limits of the

capacity of the engine and of speed, the heavier the train the less coal is required per ton-mile. This argument applies to the loading of engines, whether heavy or light, but its force is greatest in connection with very powerful locomotives. This may be demonstrated by coal reports kept for relatively long periods. It takes more oil to lubricate a heavy engine than a light one; but this too should be referred to the ton-mile, when it appears as a saving in spite of the great increase in steam pressure and the dimensions of journals. The same holds true in regard to the cost of repairs; they also will increase, but not in proportion to the additional work done. With two engines operating on the same grades, one built to haul 600 tons and the other 900 tons, the relative total cost of operation per 1,000 ton-miles may be taken at the ratio of about 47 to 36, or a difference of about 23 per cent, or more than is usually expected from compounding. We are more fortunate than our English cousins in having comparatively large limits for the size of our engines, and comparatively few of us have reached our limits yet.

At our last meeting at this place, the compound locomotive was pronounced "in the balance." It has, however, gained many friends, as experience has demonstrated that the strictly "compound features" have given but very little trouble, and it is not now doubtful that this type of engine is advantageous. It needs, however, to be more carefully designed, even more than the simple engine, as regards the details which give trouble by breaking, because the strains are greater at times, and less uniform. The tendency toward heavier loading has been favorable to compounds, because of the possibilities of greatly increasing their pulling power at critical points on summits by the use of live steam in the low pressure cylinder.

The possibilities of lightening parts by the use of improved material, whereby capacity may be increased without increasing weight, should be utilized to the utmost. Larger boilers may be built without increase of total weight and we may be encouraged in this by the great improvement of recent years in marine work.

It would take too long to do more than enumerate partially the directions in which we may improve locomotives. The following need our attention: The reduction of waste power of the cylinder by reducing back pressure and condensation; piston valves; feed-water purification; the forms of fire boxes and other factors tending to reduce stay bolt strains and failures; more thorough lagging of the boilers at the sides and front of the fire box; the further use of cheap fuels and care in the matter of details which will prevent engine failures on the road. All these subjects are before us and all of them give promise of good returns for the time and money spent upon them.

In our shops, we have too often a lot of buildings which have received additions from time to time, without a definite plan, until we have many unsatisfactory conditions unfavorable to economical work. We permit our shop plants to run down until some day we find they will no longer serve and they must be replaced with a complete new plant. It is better to plan carefully in the first place, providing for extensions, and then figure on a fair depreciation, and by spending a specified sum each year no renewal or general house cleaning of the entire plant need ever be necessary. It is our duty to properly impress this upon our superiors. Although it may be difficult to carry out the plan, business policy demands it.

The distribution of power in shops needs thought. We have electricity, compressed air, and also the gas engine to aid us, and I predict that after ten years we

shall look back with surprise at the prevailing shop power methods of the present. We need more power cranes and more modern and powerful tools. We must give more attention to the cost of work and to those commercial methods that make success or failure in manufacturing establishments. The welfare and comfort and the surroundings of our men, both on and off duty, interest us now, but much more ought to be done in these matters in the lines of reading rooms, places of recreation and in providing lectures, instruction and entertainment. We should use the technical papers intelligently. It is a good plan for the head of the Motive Power Department to mark articles and send them to their Master Mechanics and such other employes as they would deem wise, asking for comments and suggestions. Will not a little work in this direction pay well?

Not many years ago acrimonious discussions were printed in technical papers, tending to show that English *versus* American locomotive practice had two sides, and I believe that our English brothers would be the gainers were they to look to us in some of the things that we are doing in this country, and it would not be amiss if we were to study more closely some of their methods. It is by studying the best methods adopted by the other fellow that we can expect to improve our own conditions and lay aside some of our old-time practices.

In conclusion I wish to direct attention to the eight very important subjects before us for discussion this year. Of these there are four that touch all of us in a vital way: the opportunity to discuss methods for purifying feed water; the merits of cast-iron and steel-tired wheels; advantages of the "ton-mile basis" for motive power statistics; the best method of applying stay bolts and the use of nickel steel—all offer means of learning how to save large sums of money to those whom we represent, and I hope to be one of many who will carry away a great deal of money-saving information, and we shall do this if the members will freely state their experience and will put forth their ideas in the meetings as freely as in the intermissions and recesses.

Agreeable to the resolution by Messrs. J. H. Setchel, A. M. Waitt and Peter H. Peck, and concurred in by this Association, wherein the Executive Committee was instructed to confer with the Executive Committee of the Master Car Builders' Association and arrange for the consolidation of the two associations, etc., I have to state that your Executive Committee was convened in joint meeting with the Executive Committee of the Master Car Builders' Association, and the majority of the members of the Executive Committees of both Associations were not in favor of consolidating or merging the two Associations into one under any name. A plan, however, was agreed upon that will enable the Associations to conduct their business and get through in one week, and while it was not just in line with the action of this Association last year, I think it is the best plan we can get, under existing conditions, and I hope that it will meet with your favor, and that when the matter will be presented it will have your full indorsement. A suitable committee has been appointed to present the same to both the Master Car Builders' and this Association.

In order to make this the best convention we ever held, I wish to ask for prompt and careful discussion of the reports, and in expressing ourselves let us talk as we write letters, using a maximum of thought and a minimum of words, to the end that every moment may be fittingly filled. I would like to recommend that a

committee be appointed to report at the next convention, upon the subject, "What can the Master Mechanics' Association do to increase its usefulness."

I must not be unmindful of the work done by the Executive Committee and the Committee on Subjects, and I take this opportunity of expressing to each one my pleasure in recording the cheerful and efficient manner in which they have handled their work, and I am sure I voice the sentiment of the Association when I, in their behalf, as well as personally, extend to you hearty thanks.

THE PRESIDENT: Just one moment, if you please. It is customary to allow a recess of a few minutes for those who wish to withdraw from the convention room to do so. It is not at all obligatory, however. Those of you who would like to remain we would be glad to have with us. We will now have five minutes' intermission.

A recess of five minutes was taken.

THE PRESIDENT: The convention will come to order, please. We will now take up the order of business, and the first order of business is to take action on the minutes of the last meeting. You have them before you in your offices, or here, and a motion is now in order. What is your pleasure?

MR. ANGUS SINCLAIR: I move that the minutes be received as printed.

The motion was carried.

THE PRESIDENT: We will now hear the report of the Secretary.

Secretary Cloud read his annual report, as follows:

At the date of the last convention the membership of the Association was as follows:

Active members	599
Honorary members	25
Associate members	18
Total	642

Since that date four active and three honorary members have died. Two active members have been elected honorary members. During this time thirty-nine new active members have been added to the rolls, and twenty-six names have been dropped for nonpayment of dues and other causes, and these, together with other changes, makes the membership at the present time as follows:

Active members	609
Honorary members	26
Associate members	18
Total	653

The members who have died during the year, according to the records of the Secretary, are as follows:

Active Members — Frank Bruce, T. A. Fraser, J. R. Wagner, O. De Young.
Honorary Members — Wilson Eddy, J. S. McCrum, J. L. White.

The cash collected by the Secretary since the last report, up to and including June 2, the date of closing the books preparatory to this report, is as follows:

To Dues Collected from Members	$2,715.00
" Sale of Proceedings	1,252.01
" Interest on Bank Balance	4.34
Total receipts	$3,971.35

The disbursements by the Secretary during the same time have been as follows:

By Paid Reporting Convention of 1898	$ 133.00
" " Expenses Convention of 1898	86.00
" " Printing	1,247.14
" " Tracings, etc	53.00
" " Electros	59.67
" " Expenses of Committee	34.09
" " Discount	15.31
" " Expressage	8.50
" " Telegrams	6.40
" " Office Supplies	6.94
" " Revenue Stamps	1.50
" " Stamps and Stamped Envelopes	216.99
" " Salary Secretary, June 1, 1898, to June 20, 1899	1,200.00
" " Balance Remitted to Treasurer, June 10	902.81
Total disbursements	$3,971.35

It will be seen that there are no funds belonging to the Association now in the hands of the Secretary. There are no unpaid bills of this Association, nor any outstanding accounts unpaid.

The arrears of unpaid dues amount to $890.

A detailed statement of the dues collected during the year is also attached and forms a part of this report.

The four scholarships of the Association at the Stevens Institute of Technology are taken, and the first vacancy to occur will be in the fall of 1900, unless unforeseen contingencies should arise.

Respectfully submitted,

JOHN W. CLOUD, *Secretary.*

DETAILS OF DUES COLLECTED FROM MEMBERS.

1898.					
June 7	Q. Lamplugh	$ 5.00		*Brought forward*	$25.00
" 13	T. E. Cannon	15.00	June 13	J. J. Thomas, Jr.	5.00
" 13	W. C. Dallas	5.00	" 13	W. T. Smith	10.00
	Carried forward	$25.00	" 13	T. W. Macfarlane	5.00
				Carried forward	$45.00

		Brought forward...	$45.00
June	14	B. F. Griffin.....	5.00
"	17	F. H. Dehn.....	5.00
"	20	T. Tresize.....	5.00
"	20	T. McCann	5.00
"	20	E. T. White.....	10.00
"	20	T. Aldcorn	10.00
"	20	G. S. Allin.....	5.00
"	20	W. C. Arp.....	5.00
"	20	A. J. Beltz	5.00
"	20	I. Bond.....	5.00
"	20	J. O. Bradeen	5.00
"	20	P. H. Brangs.....	5.00
"	20	R. H. Briggs	5.00
"	20	D. Brown.....	5.00
"	20	T. R. Browne	5.00
"	20	E. D. Bronner.....	5.00
"	20	I. W. Clarke.....	5.00
"	20	J. J. Conolly	5.00
"	20	C. J. Cooper	15.00
"	20	W. D. Crossman...	15.00
"	20	C. A. Delaney.....	5.00
"	20	H. Delaney	5.00
"	20	M. J. Drury.....	5.00
"	20	John Ellis.....	5.00
"	20	R. L. Ettinger.....	5.00
"	20	N. Frey.....	5.00
"	20	W. Garstang	5.00
"	20	J. C. Glass.....	10.00
"	20	H. D. Gordon	5.00
"	20	J. T. Gordon.....	5.00
"	20	J. A. Graham.....	5.00
"	20	B. Haskell.....	5.00
"	20	L. B. Heers	5.00
"	20	G. A. Henderson...	5.00
"	20	F. J. Hennessey ...	5.00
"	20	F. T. Hyndman ...	5.00
"	20	R. H. Johnson.....	5.00
"	20	W. Kells.....	5.00
"	20	G. W. Kenney.....	5.00
"	20	L. Kistler.....	5.00
"	20	D. M. King.....	5.00
"	20	H. L. Leach	5.00
"	20	J. H. Leeds.....	5.00
"	20	P. Leeds.....	5.00
		Carried forward...	$300.00

		Brought forward...	$300.00
June	20	T. S. Lloyd.....	5.00
"	20	J. Mackenzie	5.00
"	20	G. S. Mackinnon...	5.00
"	20	J. Maglenn.....	5.00
"	20	A. E. Manchester..	5.00
"	20	E. S. Marshall.....	5.00
"	20	W. McIntosh.....	5.00
"	20	John Medway	5.00
"	20	G. W. Miller.....	5.00
"	20	E. A. Miller.....	5.00
"	20	R. Miller	5.00
"	20	P. H. Minshull....	5.00
"	20	E. F. Moore	5.00
"	20	J. G. Neuffer	5.00
"	20	L. C. Noble.....	5.00
"	20	W. H. Nuttall.....	5.00
"	20	W. O'Herin.....	5.00
"	20	H. M. Pflagler.....	5.00
"	20	C. H. Quereau.....	5.00
"	20	C. E. Rettew	5.00
"	20	O. H. Reynolds....	5.00
"	20	F. Robinson.....	10.00
"	20	T. Rumney.....	5.00
"	20	H. Schlacks.....	5.00
"	20	J. H. Setchel	5.00
"	20	H. J. Small	5.00
"	20	F. C. Smith.....	5.00
"	20	J. Y. Smith.....	10.00
"	20	William Smith.....	5.00
"	20	R. H. Soule.....	5.00
"	20	O. Stewart	5.00
"	20	G. H. Shone	5.00
"	20	H. Tandy.....	5.00
"	20	John Taylor.....	5.00
"	20	W. H. Thomas	5.00
"	20	G. M. Tower.....	5.00
"	20	S. R. Tuggle	5.00
"	20	J. S. Turner	5.00
"	20	D. Van Alstine	5.00
"	20	A. M. Waitt.....	5.00
"	20	B. Warren	5.00
"	20	W. B. Warren	5.00
"	20	C. P. Weiss	5.00
"	20	D. A. Wightman...	5.00
		Carried forward...	$530.00

		Brought forward...	$530.00
June	20	J. W. Witmer	5.00
"	20	F. J. Zerbee.....	5.00
"	28	George James.....	5.00
"	28	W. L. Hoffecker...	5.00
"	28	C. H. Barnes.....	5.00
"	28	E. W. Jerome.....	5.00
"	28	W. J. Davis.....	5.00
"	29	A. McDuff.....	5.00
"	29	A. Sinclair.....	5.00
"	30	R. Quayle.....	5.00
"	30	W. H. V. Rosing ..	5.00
July	1	C. Hackney	5.00
"	1	J. McNaughton	5.00
"	1	J. W. Stokes	5.00
"	1	J. E. Keegan.....	5.00
"	1	William Swanston..	5.00
"	1	C. H. Howard.....	5.00
"	1	J. B. Barnes.....	5.00
"	1	P. H. Murphy.....	5.00
"	1	J. M. Boon.....	5.00
"	2	H. A Gillis.....	5.00
"	2	P. P. Foller	5.00
"	2	R. C. Blackall	5.00
"	2	G. B. Ross.....	5.00
"	2	M. Rickert.....	5.00
"	2	T. A. Lawes.....	5.00
"	2	G. W. Cushing.....	5.00
"	5	W. J. Tollerton	5.00
"	5	A. V. McDonald...	10.00
"	5	M. L. Hinman.....	5.00
"	5	C. B. Royal.....	5.00
"	5	C. A. DeHaven....	5.00
"	5	T. H. Tyrrell.....	5.00
"	5	A. Mitchell.....	5.00
"	5	J. B. Johnson.....	5.00
"	5	G. Thompson.....	5.00
"	5	R. Wells.....	5.00
"	5	W. L. Holman.....	5.00
"	5	H. Ryder	5.00
"	5	G. M. Basford	5.00
"	5	R. Moran	5.00
"	5	P. Wallis	5.00
"	5	J. L. Brown.....	5.00
"	5	E. M. Herr.....	5.00
		Carried forward...	$755.00

		Brought forward...	$755.00
July	6	M. T. Carson.....	5.00
"	6	W. H. Brehm.....	5.00
"	6	J. W. Cloud	5.00
"	7	I. Conroe	5.00
"	7	J. Wheelock.....	5.00
"	7	W. Fuller.....	5.00
"	7	W. H. Taylor.....	5.00
"	7	W. H. Lewis	5.00
"	7	C. F. Baker.....	5.00
"	7	W. S. Morris	5.00
"	7	A. E. Benson.....	5.00
"	7	L. B. Paxson	5.00
"	7	G. R. Joughins.....	10.00
"	7	F. B. Miles.....	5.00
"	7	F. J. Cole.....	5.00
"	7	A. Vail	5.00
"	7	H. Bartlett	5.00
"	7	E. L. Weisgerber ..	5.00
"	7	J. W. Sanford	5.00
"	7	R. M. Galbraith....	5.00
"	7	R. J. Gross.....	5.00
"	7	J. H. McConnell...	5.00
"	7	C. M. Stansbury....	5.00
"	9	J. H. Manning.....	5.00
"	9	Wilbur Green.....	5.00
"	9	A. E. Mitchell.....	5.00
"	11	G. N. Riley	5.00
"	11	G. H. Baker.....	10.00
"	11	J. J. Ryan.....	5.00
"	11	J. W. Addis.....	5.00
"	11	R. C. Esson.....	5.00
"	11	Thomas Shaw	5.00
"	11	J. Hinchey.....	5.00
"	11	F. W. Dean	5.00
"	11	R. B. Reading.....	10.00
"	11	T. W. Newell	5.00
"	12	A. M. White	5.00
"	12	H. N. Sprague.....	5.00
"	12	F. W. Moore	5.00
"	14	A. Hendee.....	5.00
"	14	W. H. Lewis	5.00
"	14	D. Hawksworth....	5.00
"	14	W. O. Lucas.....	5.00
"	14	L. Greaven.....	5.00
		Carried forward...	$990.00

		Brought forward...	$990.00
July	14	John Hopwood	10.00
"	14	W. L. Austin.....	5.00
"	14	S. L. Vauclain.....	5.00
"	14	A. B. Johnson.....	5.00
"	14	C. K. Bowles.....	5.00
"	15	H. G. Bechhold....	5.00
"	15	H. A. Childs	5.00
"	16	J. M. Wallis.....	5.00
"	16	J. A. Keegan.....	5.00
"	16	G. L. Potter.....	5.00
"	16	J. W. Roberts	5.00
"	16	C. G. Turner	5.00
"	16	W. H. Taft	5.00
"	16	G. W. Butcher.....	5.00
"	18	T. Lyon	5.00
"	18	M. M. Reid.....	5.00
"	18	J. Glaser.....	5.00
"	18	G. Knapp.....	5.00
"	18	H. M. Sehrt.....	5.00
"	18	I. W. Fowle.....	5.00
"	18	F. D. Casanave	5.00
"	18	A. J. Pitkin...	5.00
"	18	W. E. Symons.....	5.00
"	19	J. E. Sague.....	5.00
"	19	W. L. Gilmore.....	5.00
"	20	G. W. West.....	5.00
"	20	J. R. Groves.....	5.00
"	20	J. L. Driscoll.....	5.00
"	20	H. S. Hayward	5.00
"	20	S. T. Balkam.....	5.00
"	20	G. Gregory.....	5.00
"	20	C. E. Turner.....	5.00
"	21	O. Clarke.....	5.00
"	22	H. H. Vaughan....	5.00
"	22	James Strode	5.00
"	22	W. S. Hancock....	5.00
"	22	J. Potton.....	5.00
"	23	T. Millen	5.00
"	23	J. Cockfield	5.00
"	25	E. Ryan	5.00
"	25	S. P. Bush	5.00
"	25	J. J. Tomlinson	5.00
"	25	F. Hufsmith.....	5.00
"	25	A. McCormick.....	5.00
		Carried forward...	$1,215.00

		Brought forward...	$1,215.00
July	26	G. W. Rhodes.....	5.00
"	27	H. Elliott.....	5.00
"	27	J. Horrigan	5.00
"	27	W. J. McLean.....	5.00
"	29	G. L. Fowler.....	5.00
"	29	E. E. Davis.....	5.00
"	29	M. J. Redding.....	5.00
"	29	C. J. Clifford	5.00
"	29	C. A. Thompson...	5.00
"	29	H. Pollitt	5.00
"	29	F. A. Chase.....	5.00
"	29	J. J. Ellis	5.00
"	30	J. A. Hill.....	5.00
"	30	W. W. Atterbury...	5.00
Aug.	1	C. H. Wiggin.....	5.00
"	1	J. L. Greatsinger...	5.00
"	1	C. M. Babcock.....	5.00
"	1	G. L. Romans	5.00
"	2	W. Forsyth.....	5.00
"	4	T. W. Heintzelman.	5.00
"	4	R. W. Bushnell....	5.00
"	4	A. Pilsbury.....	5.00
"	4	T. W. Place.....	5.00
"	4	G. L. Dickson.....	5.00
"	4	A. S. Erskine	5.00
"	4	D. J. Justice.....	5.00
"	6	J. W. Hall.....	5.00
"	6	A. C. Hinckley	5.00
"	8	J. Collinson	5.00
"	8	J. L. Lawrence	5.00
"	9	F. C. Cleaver.....	5.00
"	9	John Foulk.....	5.00
"	10	P. Maher	5.00
"	10	G. F. Wilson.....	5.00
"	10	W. Renshaw	5.00
"	10	J. Hainen.	5.00
"	10	F. J. Leigh.....	5.00
"	11	J. W. Hill.....	5.00
"	12	W. Cockfield.....	5.00
"	15	S. M. Dolan.....	5.00
"	15	J. M. Keith	5.00
"	19	F. B. Griffith	5.00
"	19	T. Paxton.....	5.00
"	19	William Laing.....	5.00
		Carried forward...	$1,435.00

		Brought forward...	$1,435.00
Aug.	22	J. S. Cook	5.00
"	22	C. J. McMaster	5.00
"	22	A. Beckert	5.00
"	22	A. Shields.....	5.00
"	23	W. F. M. Goss.....	5.00
"	27	H. T. Thomas	5.00
"	29	D. D. Briggs	5.00
"	29	J. R. Van Cleve....	5.00
"	29	J. W. Marden	5.00
"	29	W. Cross.....	5.00
"	30	P. H. Peck.....	5.00
"	31	H. S. Bryan.....	5.00
"	31	J. Fitzmorris.....	5.00
"	31	C. E. Stevenson....	5.00
"	31	H. Tregelles	5.00
Sept.	2	V. B. Lang.....	5.00
"	5	W. Augustus.....	5.00
"	5	J. Townsend.....	5.00
"	5	G. W. Stevens.....	5.00
"	5	H. A. Gillis	5.00
"	5	C. J. Mellin	5.00
"	8	R. L. Herbert.....	5.00
"	9	E. M. Lake.....	5.00
"	13	F. F. Tynan.....	10.00
"	13	L. M. Butler	5.00
"	13	J. D. Campbell	5.00
"	13	Oscar Antz.....	5.00
"	13	J. D. Barnett.....	5.00
"	15	J. F. Dunn.....	5.00
"	14	E. C. Bates	5.00
"	15	J. G. Beaumont	5.00
"	19	James Cullen	5.00
"	19	M. T. Carson.....	5.00
"	20	F. M. Whyte.....	5.00
"	20	A. Cooke	5.00
"	23	James Hardie.....	5.00
"	26	A. Gordon	5.00
"	26	C. H. Cory.....	5.00
"	26	A. L. Beattie	5.00
"	26	T. R. Rotheram....	5.00
"	26	John Gill.....	5.00
"	28	A. Williams.....	5.00
Oct.	3	W. A. Brown.....	5.00
"	3	Z. T. Sprigg.....	5.00
		Carried forward...	$1,660.00

		Brought forward...	$1,660.00
Oct.	5	A. S. Grant	5.00
"	6	A. G. Leonard.....	5.00
"	17	A. W. Belcher.....	5.00
"	17	E. Dawson.....	10.00
"	18	C. B. Hogsett.....	5.00
"	18	H. D. Galbraith....	5.00
"	19	J. C. Hayden.....	5.00
"	21	F. W. Johnstone ...	5.00
"	27	A. A. Bradeen.....	5.00
"	29	A. J. Cromwell	5.00
"	31	C. DeGrass.....	5.00
"	31	P. E. Garrison	5.00
Nov.	7	H. M. C. Skinner ..	5.00
"	7	F. W. Webb.....	5.00
"	9	H. W. Hibbard....	5.00
"	14	H. C. Bocquet.....	5.00
"	19	W. J. Wilcox.....	5.00
"	21	W. Thow	5.00
"	21	M. D. Brown.....	5.00
"	25	E. La Lime	5.00
"	30	A. T. West.....	5.00
Dec.	2	J. B. Michael.....	5.00
"	3	J. R. Wagner.....	5.00
"	6	J. A. Hanglin.....	5.00
"	12	M. K. Barnum.....	5.00
"	12	J. M. Davies.....	5.00
"	14	H. E. Walker	5.00
"	15	A. Villasenor	5.00
"	16	J. G. Tomlinson....	5.00
"	24	T. B. Purves, Jr....	5.00
"	27	W. D. Holland	5.00
"	29	C. M. Taylor	5.00
"	30	P. A. Logan.....	10.00
"	31	J. N. Barr.....	5.00
"	31	C. R. Yohn.....	5.00
"	31	James Macbeth.....	5.00
"	31	John Bean	5.00
"	31	I. N. Kalbaugh	5.00
"	31	A. L. Humphrey. .	5.00
"	31	D. S. Cooper.....	5.00
1899.			
Jan.	5	B. F. Marshall.....	5.00
"	5	Frank Bruce..	5.00
"	5	G. A. Ferguson	5.00
		Carried forward...	$1,885.00

		Brought forward...	$1,885.00
Jan.	5	J. J. Thomas, Jr ...	10.00
"	6	W. A. Nettleton....	5.00
"	6	W. A. Smith.....	5.00
"	7	W. A. Foster.....	5.00
"	7	R. Tawse	5.00
"	9	J. Lythgoe	5.00
"	9	P. T. Lonergan	5.00
"	9	E. La Lime	5.00
"	9	J. O'Brien.....	5.00
"	9	F. Mertsheimer	5.00
"	9	W. P. Orland.....	5.00
"	10	J. T. Robinson.....	5.00
"	10	D. O. Shaver	5.00
"	12	S. Higgins	5.00
"	16	George Gibbs.....	5.00
"	16	F. W. Twombly....	5.00
"	17	A. L. Studer.....	5.00
"	18	G. A. Hancock	10.00
"	18	E. A. Williams	5.00
"	18	J. Christopher	5.00
"	19	A. B. Minton	5.00
"	19	A. W. Gibbs.....	5.00
"	19	J. Torrance.....	5.00
"	23	W. Hassman	5.00
"	23	C. Skinner	5.00
"	23	W. E. Killen.....	5.00
"	24	J. Billingham.....	5.00
"	25	W. H. Marshall....	5.00
"	25	A. Mitchell.....	5.00
"	25	W. T. Reed	5.00
"	30	A. Gardner.....	5.00
"	30	S. K. Dickerson....	5.00
Feb.	1	L. R. Pomeroy.....	5.00
"	2	M. J. Rogers	5.00
"	6	C. F. Thomas.....	5.00
"	16	W. F. Bradley	5.00
"	20	John Hair	5.00
"	20	H. Middleton	10.00
"	20	J. R. Spragge.....	5.00
"	20	C. F. Lape.....	5.00
"	25	W. E. Amann.....	5.00
"	27	J. McNabb	5.00
"	27	C. H. Prescott	5.00
Mch.	1	P. C. Rusch.....	5.00
		Carried forward...	$2,120.00

		Brought forward...	$2,120.00
Mch.	3	W. J. Hemphill....	5.00
"	6	W. Cockfield	5.00
"	9	C. E. Fuller.....	5.00
"	10	F. Hedley.....	5.00
"	13	J. M. Dow	5.00
"	15	A. W. Greenwood..	5.00
"	15	C. Robkin	5.00
"	15	T. E. Adams.....	5.00
"	15	F. Roth.....	5.00
"	15	F. F. Gaines	5.00
"	16	W. J. Davis	10.00
"	16	F. Rearden.....	5.00
"	16	G. E. Branch	5.00
"	16	W. H. Traver.....	5.00
"	16	W. Lavery	5.00
"	16	R. D. Sutherland...	5.00
"	17	J. S. Patterson.....	5.00
"	17	John Hewitt.....	5.00
"	17	Rufus Hill	5.00
"	17	W. Buchanan.....	5.00
"	17	S. E. Stout.....	5.00
"	18	John Player	5.00
"	18	J. S. Chambers	5.00
"	20	J. P. McCuen.....	5.00
"	20	J. J. Casey	5.00
"	20	A. W. Twombly....	5.00
"	20	L. H. Waugh.....	5.00
"	21	H. Stillman	5.00
"	21	G. W. Smith	5.00
"	21	G. Donahue	5.00
"	22	J. E. Battye	5.00
"	22	J. Cullinan	5.00
"	22	J. C. Haggett.....	5.00
"	23	R. Atkinson.....	10.00
"	24	R. P. C. Sanderson.	5.00
"	24	T. A. Foque.....	5.00
"	24	E. E. Hudson	5.00
"	24	H. M. Minto	5.00
"	25	E. Chamberlin.....	10.00
"	27	S. L. Bean.....	5.00
"	27	J. C. Shields.....	5.00
"	28	T. Walsh	5.00
"	31	J. H. Buckalew....	5.00
April	3	G. A. Miller.....	5.00
		Carried forward...	$2,355.00

		Brought forward...	$2,355.00
April	3	J. C. Homer.....	5.00
"	3	N. W. Sample.....	5.00
"	10	J. H. Moore.....	5.00
"	15	G. H. Baker.....	5.00
"	17	J. M. Coale	5.00
"	20	James Carr.....	5.00
"	20	L. S. Randolph	5.00
"	21	F. R. F. Brown	5.00
"	21	E. W. Jerome	5.00
"	22	J. McDonough.....	5.00
"	22	F. Slater.....	5.00
"	24	H. T. Peyton.....	5.00
"	24	J. C. Slater.....	5.00
"	24	R. English.....	5.00
"	24	F. U. Mahl.....	5.00
"	27	W. H. Hudson	5.00
"	29	A. Adams.....	5.00
May	1	R. Allin	5.00
"	1	R. E. French.....	5.00
"	3	E. La Lime	5.00
"	6	S. B. Crawford.....	10.00
"	6	A. Santer	5.00
"	6	W. O. Lucas	5.00
"	6	A. B. Cook.....	5.00
"	6	T. S. Beauclerk....	5.00
"	8	F. E. Tubbs.....	5.00
"	8	J. H. Berry.....	10.00
"	9	J. L. Smith.....	5.00
"	9	W. T. Smith.....	5.00
"	9	H. Monkhouse	5.00
"	10	F. A. Givin.....	10.00
		Carried forward...	$2,525.00

		Brought forward...	$2,525.00
May	10	J. Marchbanks.....	5.00
"	11	H. C. Smith.....	5.00
"	15	A. Moraga	10.00
"	15	H. G. Bechhold....	5.00
"	15	G. W. Gage.....	5.00
"	15	C. W. Lee	5.00
"	16	C. J. Langston.....	5.00
"	17	W. Sinnott.....	5.00
"	17	C. A. Ward.....	5.00
"	18	O. H. Jackson.....	10.00
"	18	Charles Graham, Jr.	5.00
"	19	F. F. Tynan	5.00
"	19	A. E. Tremp.....	5.00
"	20	R. M. Pringle.....	5 00
"	22	F. J. Harrison	10.00
"	22	C. T. McElvaney...	5.00
"	22	M. Roberts.....	5.00
"	23	T. Paxton.....	5.00
"	24	William Jennings ..	10.00
"	25	T. Carmody	5.00
"	25	P. Ryan	5.00
"	27	F. M. Lawler.....	10.00
"	27	H. G. Hudson	5.00
"	29	H. Osborne.....	10.00
"	29	C. Lindstrom	5.00
"	30	J. F. Deems	5 00
"	30	F. G. Brownell	5.00
June	1	L. R. Johnson.....	10.00
"	1	W. H. Young.....	5.00
"	1	A. Brown	10.00
		Total	$2,715.00

THE PRESIDENT: You have heard the report of the Secretary. What is your pleasure, gentlemen?

MR. G. R. HENDERSON: I move that the report be received.

The motion was carried.

MR. MCCONNELL: Mr. Chairman, I move that the report of the Secretary be now adopted.

THE PRESIDENT: Perhaps that is not essential, but possibly it will take a shorter time to put it through. All in favor of that motion will say "aye"; contrary "no."

The motion was carried.

THE PRESIDENT: Mr. Barr will now present the report of the Treasurer, he being the Treasurer.

MR. J. N. BARR, the Treasurer, submitted the following report:

TREASURER'S STATEMENT OF ACCOUNT.

On hand June 14, 1898	$2,214.13
Received June 10, 1899	836.14
	$3,050.27
Received June 19, 1899	66.67
	$3,116.94

J. N. BARR,
Treasurer.

THE PRESIDENT: What shall you do with the report, gentlemen?

MR. SINCLAIR: I move that the report be received and incorporated in the minutes.

The motion was carried.

THE PRESIDENT: I beg to advise you now, gentlemen, that within the power of the Executive Committee it has fixed the dues for the ensuing year at $5, the same as heretofore. We will not have an intermission now for that, as a number of you have already paid your dues. We will now proceed with the election of an Auditing Committee. Nominations are in order, gentlemen. Whom shall we have as that committee?

MR. SINCLAIR: I nominate L. R. Pomeroy.

THE PRESIDENT: Three members if you please; we want two others.

MR. HENDERSON: I nominate A. E. Mitchell.

MR. MORRIS: I nominate A. F. Stewart.

MR. H. J. SMALL: I move that the nominations be closed.

THE PRESIDENT: We only provide for a committee of three, Mr. Small, so that closes it. The three gentlemen named will be the Nominating Committee.

A MEMBER: They have to be balloted for.

THE PRESIDENT: I accept the motion. Is there any second to Mr. Small's motion?

A member seconded Mr. Small's motion that the nominations be closed, and it was put and carried.

MR. MCCONNELL: I move that the rules be suspended, and

that the Secretary be instructed to cast the vote of the convention for the three gentlemen just named as the Auditing Committee.

The motion was carried.

MR. CLOUD: The gentlemen are therefore elected. I take this opportunity of saying to the chairman of the committee that the accounts to be audited are here and can be had at any time, either here or in the committee's office.

THE PRESIDENT: The Secretary has cast the unanimous vote of the Association for these three gentlemen named for Auditing Committee, and as soon as they want to they can proceed to audit the accounts. Next is unfinished business.

MR. CLOUD: I think the report of the Executive Committee on the subject of shortening the time required to hold the conventions ought properly to come in here.

THE PRESIDENT: Mr. McConnell will present that to the meeting.

MR. MCCONNELL: Mr. Chairman, I desire to say that the Executive Committee of the Master Mechanics' Association met with the Executive Committee of the Master Car Builders' Association, in Chicago, and it was decided at that meeting that they would recommend to the two Associations that the time of the two meetings be changed in order to have the meetings of the Associations take place inside of four days; and it was suggested, and a committee was appointed to confer with both Associations to this effect — that they would recommend the meeting of the two Associations on Tuesday, and that the address of the presidents of both Associations should be had in the morning of that day; that the balance of the day should be taken up by the Master Mechanics' Association with its business. The second day would be devoted entirely to Master Car Builders' work, in order to give it the whole day for the interchange rules. On the morning of Thursday the Master Mechanics' would hold a session, and the Master Car Builders' would hold one in the afternoon. On the fourth day, the Master Car Builders' will hold a session in the morning, and the Master Mechanics in the afternoon. Saturday would be used if it was found necessary to continue the convention further. This matter was presented to the Master Car Builders' Association, and after some discussion the report was amended so as to read as follows: The recommendation of the Master Car Builders' Association was that they should meet on Monday and occupy three days, the Master Mechanics to come in on the fourth

day and occupy the balance of the week, if necessary, and the matter was referred to the Executive Committee to take it up with the Master Mechanics' convention, with the hope that this would meet with their approval, and arrangements could be made to carry out this programme.

THE PRESIDENT: You have heard the report, gentlemen. What shall we do with that report?

MR. HENDERSON: Mr. President, it might be of some advantage to know what action the Master Car Builders took on this same subject.

THE PRESIDENT: Mr. McConnell has just explained that. Mr. McConnell will please explain that again.

MR. MCCONNELL: When this question came up before the Master Car Builders' Association, a resolution was introduced there that it was the sense of the Master Car Builders' meeting that they should commence on Monday, and occupy Monday, Tuesday and Wednesday, and it was hoped that the Master Mechanics would join in and occupy Thursday, Friday and Saturday, and the matter was referred to the Executive Committee of the Master Car Builders' Association, with power to act, and take it up with the committee that might be appointed by the Master Mechanics' Association.

MR. L. R. POMEROY: I would move, Mr. President, that the report be received and referred to the Executive Committee with power to co-operate with the Executive Committee of the Master Car Builders' Association. (Seconded.)

THE PRESIDENT: You have heard the motion, which is that the report be received, and that it be referred to the Executive Committee, and that they are instructed to confer with the Executive Committee of the Master Car Builders' Association with power to act. What is your pleasure? Any remarks on the motion? All in favor of the motion will say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: The Secretary has an announcement or two to make.

MR. CLOUD: Further, in regard to unfinished business, there were three applications for associate membership at the last convention, all of which were referred to committees to report upon. These committees have all reported back to the Executive Committee, and the

Executive Committee has considered the reports and recommend the election of the gentlemen as associate members. They are Prof. R. A. Smart and Messrs. Strickland L. Kneass and Clement F. Street. The Executive Committee, however, calls the attention of the Association to the fact that there are now eighteen associate members, and the constitution allows but twenty, and it suggests for this and for other good reasons that Mr. J. H. Leeds, who is now an associate member, should first be elected to honorary membership, which will leave room for three new associates.

THE PRESIDENT: Gentlemen, what shall we do in the case of Mr. J. H. Leeds? It seems necessary that he should be changed to honorary member in order to make room for these other gentlemen named. What is your pleasure concerning making Mr. Leeds an honorary member? I understand his residence is abroad and he is abroad most of the time.

MR. MORRIS: I move that Mr. J. H. Leeds be made an honorary member.

MR. O. STEWART: I second the motion.

THE PRESIDENT: This is entirely within our power, I believe, and it is right and fitting that it should be done under the Constitution. You have heard the motion that he be made an honorary member. It is simply a transfer from associate membership to honorary membership.

The motion to transfer Mr. Leeds to honorary membership was carried.

THE PRESIDENT: He is elected as an honorary member. I might say for your information, with respect to the other associate members, that it is necessary for us to elect them by ballot. The names are Prof. R. A. Smart, of Purdue University; Strickland L. Kneass, in connection with the Sellers Company, and Clement F. Street, of the Dayton Malleable Iron Company.. The order is to take up one at a time. Mr. Sinclair, Mr. White and Mr. Soule will please act as tellers. Take one name at a time, gentlemen. We will vote on Prof. R. A. Smart first.

MR. R. H. JOHNSON: Mr. President, if I am in order, I would move you that the rules be suspended in that particular case, and that the Secretary be instructed to cast the ballot for the three gentlemen mentioned.

THE PRESIDENT: For your information, Mr. Johnson — before a second is received to that — I would say that that is one part of the rules that is not allowed to be suspended. You understand, gentlemen, that, in voting for Prof. R. A. Smart, you simply say "Yes" or "No." It has been suggested that you write the name and then say "yes" or "no," so that the ballots will not get mixed —"R. A. Smart, yes," or "R. A. Smart, no," with only one name on this ballot.

PROF. H. WADE HIBBARD: Mr. President, may we not proceed with the next name while these ballots are being counted?

THE PRESIDENT: The Secretary can make some announcements. This would be an opportune time to do that, I think, Mr. Hibbard.

MR. CLOUD: Members of the Master Mechanics' Association desiring return Pullman transportation can obtain the same from Mr. H. M. Pflager, chief mechanical inspector of the Pullman Company, who will be at the Hotel Chamberlin until Tuesday evening. (Applause.) As there is no calling of the roll to find out who attends the convention, we have placed a box with some cards near the door, and it is requested that members present will deposit at least one card during the week in that box, so as to make sure of being recorded as attending this convention. If any members desire to pay their dues at this convention, they can pay them to my assistant here, Mr. Taylor, either here just after the adjournment or in the room just across the hall, between sessions.

The McConway & Torley Company extend to this Association a cordial invitation to witness the operation of their three-stem coupler applied to two 40-ton cars on the curves of the government tracks east of the Hygeia Hotel at 4:30 this afternoon.

MR. SINCLAIR: On the election of Professor Smart seventy have voted; sixty-nine for, and one "no."

THE PRESIDENT: That elects Professor Smart an associate member. The next one we will act on is Strickland L. Kneass. Mr. W. S. Morris, our Second Vice-President, has an announcement to make which will probably interest some of you.

MR. MORRIS: If any of the members who are not provided with C. & O. transportation will call on me, I will be very glad to arrange it for them anywhere on the line.

THE PRESIDENT: You might now just as well prepare your bal-

lots for the next candidate for associate membership, Mr. Clement F. Street.

MR. SINCLAIR: Mr. President, on the election of Mr. Kneass there have been fifty-five regular votes; fifty-four "yes," and one "no."

THE PRESIDENT: It is a vote, gentlemen, and Mr. Kneass is therefore elected an associate member of the Association. Now the tellers will proceed to collect the ballots for Mr. Street's election. I might say, gentlemen, while that is going on, that is all the unfinished business we have at the table here, and if you have anything to bring before the convention under that head we should be glad to receive it now.

Mr. A. W. GIBBS: Mr. Chairman, as this convention closes the services of our Secretary, Mr. Cloud, I think it would be eminently proper to appoint a committee to draft proper resolutions in appreciation of the services of the Secretary, and if it be in order I would like to nominate Mr. Barr as chairman of the committee.

THE PRESIDENT: I wish that we shall have others in addition to Mr. Barr.

MR. GIBBS: As chairman, I mean.

THE PRESIDENT: Gentlemen, I suppose a committee of three would be sufficient.

MR. GIBBS: I suggest a committee of three.

THE PRESIDENT: How do you wish the other members to be placed on that committee, by nomination or by appointment by the chair?

A MEMBER: We did not hear over this way what they were talking about, Mr. President.

THE PRESIDENT: The motion is that inasmuch as our worthy Secretary, Mr. Cloud, is about to retire from the Association work and take up his abode in another country, that a committee of three be appointed, of which Mr. Barr shall be chairman, to draw up suitable resolutions to be presented to Mr. Cloud on his retirement from the office of Secretary of the Association. That is correct, is it, Mr. Gibbs?

MR. GIBBS: Yes, sir.

THE PRESIDENT: Now that Mr. Barr has been placed in nomination as chairman, how shall we appoint the other two members, or who shall we have for the other two members?

A MEMBER: I move that the Chair appoint the other two.

A MEMBER: I nominate Mr. Soule.

THE PRESIDENT: There is a motion before the house. The motion is that the Chair appoint the other two members. All in favor of that motion say "aye"; contrary, "no."

The motion was carried.

THE PRESIDENT: I will appoint as members of that committee Mr. Soule, as has been suggested, and I think that the friend to my right, Mr. McConnell, would be a proper man for the third member.

MR. SINCLAIR: Mr. President, here is the vote on Mr. Street. There were fifty-eight votes cast, fifty-seven "yes" and one "no." (Laughter.)

MR. BARR: Mr. Chairman, I have a little fault to find with the tellers. I have got my vote here yet, and so has Mr. Morris.

MR. MCCONNELL: I desire also to exercise my right as a free American citizen and cast my ballot.

THE PRESIDENT: They just want to put themselves on record that they did not vote "no." We will accept the votes. It is a vote, and Mr. Street is elected an associate member of the Association.

MR. SINCLAIR: Mr. President, the amended vote is sixty for and one against.

THE PRESIDENT: It does not change the announcement of the Chair.

MR. MCCONNELL: Gentlemen, all recognize how Mr. Barr voted.

THE PRESIDENT: If there is no further business under that head, we will proceed to new business, the next item on our programme. The Secretary has a communication to read to you.

MR. CLOUD: The Executive Committee instructed the Secretary to read this communication under the head of new business:

FORTRESS MONROE, VA., June 19, 1899.

To the American Railway Master Mechanics' Association, in Convention Assembled:

The National Railway Master Blacksmiths' Association sends you greeting, calls your attention to their organization and asks your co-operation towards perfecting the same, as may be consistent with your judgment and official duties.

The blacksmith shop is an important factor in railway mechanics, and the object of this association is to bring the foremen smiths together, that they may compare

notes and enlighten each other on the best methods of doing detail work under the various conditions encountered in practice. The knowledge gained, or benefit derived, is always to the advantage of superior officers and the whole mechanical department. On account of this mutual gain in knowledge and benefits, your approval is asked, and, as aforesaid, your co-operation in perfecting the organization and in arranging for the coming convention, to be held in Milwaukee, Wis., commencing on the first Tuesday of September next.

Your recognition and approval will greatly facilitate the work towards the desired end, and for which you will receive the earnest thanks of all members of the

NATIONAL RAILWAY MASTER BLACKSMITHS' ASSOCIATION,
By GEORGE LEAS,
Chairman, Committee on Arrangements, N. R. M. B. A.

THE PRESIDENT: You have heard the communication from the Master Blacksmiths' Association. What action, if any, will you take concerning it?

MR. BARR: Mr. Chairman, we all recognize the value of the Master Mechanics' Association and also the Master Car Builders' Association. Now I do not think that the Master Mechanics' Association can do better than to heartily recognize the Master Blacksmiths' Association and do all they can to encourage the men who are directly interested in that work. I will say from actual knowledge that their proceedings are extremely interesting, and on some things they do a great deal better than we do. I think, too, that if we undertook to discuss some of the subjects which they have discussed well, we would make a decided fiasco of the whole thing. It is impossible, with the work that we have to do, to be familiar with all details. The work of railroading is getting so complicated, and for us to come here and attempt to ventilate our knowledge as it is derived from the explanation of the blacksmith or the car painter, is futile — we simply can not do it. I feel that these organizations have got a definite and a useful place, and I feel, too, that one of the best actions of this Association would be to fully recognize them, and in every way give them encouragement in their work. I would make a motion that it is the sense of this Association that the work of the Master Blacksmiths' Association is fully appreciated; that we endeavor to encourage them in every possible way; that it is the sense of this Association that each of us should encourage those under our charge as far as possible to attend these meetings. (Seconded.)

THE PRESIDENT: Well, now, gentlemen, I have not got all the

motions. Mr. Cloud called my ear a minute at that time. But the sense of it is that we ought to give every encouragement to the Master Blacksmiths' Association. All in favor of that motion will manifest it by saying "aye"; contrary minded, "no."

The motion was carried.

THE PRESIDENT: I hope that we will do everything we can to develop their line of work so that we may profit thereby.

MR. C. H. QUEREAU: If I may be allowed, I would suggest that our Secretary should notify the Master Blacksmiths' Association of the action of our Association here.

THE PRESIDENT: Do you offer that in the form of a motion?

MR. QUEREAU: Yes, sir.

MR. BARR: I second the motion.

MR. CLOUD: There was a communication from the Locomotive and Car Painters' Association, which has been mislaid, but the substance of it was that they asked this Association to name one subject for that association to consider and have a report upon at its next convention.

MR. MCCONNELL: Mr. Chairman, I move that the matter be referred to the Executive Committee.

THE PRESIDENT: The motion is that the matter of a subject to come before the Master Painters' Association as coming from this Association be referred to the Executive Committee of this Association. Any remarks? All in favor of that motion will manifest it by saying "aye"; contrary minded, "no."

The motion was carried.

THE PRESIDENT: I beg to advise you also, gentlemen, that we have present with us Mr. J. A. Gohen who is the representative of the Master Car Painters' Association, and he has asked and the Executive Committee has agreed to allow him, if it meets with your approval, an opportunity to address the convention. If there is no objection, I will ask the gentleman to address you from two to three minutes — not to exceed three minutes.

MR. GOHEN: Mr. President and Gentlemen of the American Railway Master Mechanics' Association,—It would hardly be necessary for me to say anything after the pleasant remarks of Mr. Barr regarding the Master Blacksmiths' Association, and I will just say to you, please accord us the same good, heartfelt sympathy and aid that

you have accorded them, and we will appreciate it and you will certainly not be disappointed in our efforts to help you. Thank you. (Applause.)

THE PRESIDENT: I think, without further action, Mr. Gohen, you can say to your Association that the Master Mechanics' Association will extend to you their hearty and cheerful co-operation.

MR. GOHEN: Thank you, sir.

THE PRESIDENT: Have you anything else under the head of new business? There being nothing more under the head of new business, that is closed. It is now 12 o'clock and we are obliged to open up the topical discussions of the noon hour. I want to say, gentlemen, that with your indulgence, we will take up subject No. 9. We have with us today a gentleman who has to leave this afternoon and I asked that he say something about that subject, which is, "The Comparative Efficiency and Economy of Metal Flexible Joints *versus* Rubber Hose for Steam-heating Connections." Mr. Gibbs, of the Pennsylvania road, is with us, and as he wants to go away, and as that road has used it somewhat extensively, we would be glad to hear from him.

MR. A. W. GIBBS: I did not understand that I was to open the subject; but I have taken the trouble to avail myself of some records of flexible joints, which we began to use about 1892. At that time the problem of connections between our engines and tenders became troublesome on account of the oil which was thrown from the driving wheels and it gave us much trouble by destroying various kinds of flexible hose which were not adapted to resist the action of oil, and finally we tried the flexible joint which we now use, wherever we have to convey steam between engines and tenders. I find that since 1893 we have bought about 2,900 joints for about 750 engines altogether, equipped on all of the lines, in which there appear to have been about twenty-five failures from various causes, and they are used now altogether for the purpose mentioned, partly because they resist the action of oil which destroys other material, partly because there is no possibility of bursting, which is very awkward on a through train where you can not afford to stop, and partly because owing to our steam-heating system, we have to carry very heavy pressure between the engine and tender in order to operate the vacuum pumps. Ordinarily you do not have to carry much more than 40 pounds, unless you are running a dynamo in the baggage car; but we are

practically running a separate engine all the time on our passenger trains, because we have a vacuum pump in our tender. I can only say that we have used this number of metal flexible joints and appear to have but a little over two dozen failures, since 1893. I have not very much more to say, except that, while we recognize the fact that the first cost is very much greater, at the same time there are places where you can not afford to have a failure even at the expense of greater first cost; that is to say, you can afford to pay a considerable amount to avoid failures in certain important places. I can not say anything about the use of these in other places; between cars — I know nothing of that. After mentioning the good points, I would say that the principal trouble so far has been that when not in use, when you don't have steam pressure on, the pipe is injured by dust and by rattling. The remedies are two; either keep pressure on all the time or else disconnect the thing in the summer time when you are not using any steam. That is about all, Mr. Chairman, I have to say about that subject. I was asked to open it for Mr. Vogt.

THE PRESIDENT: Thank you. Are there others who have some remarks? I would ask Mr. Slater if he would not say something about this as he has had some experience — Mr. Slater, of the Chicago & North-Western Railway.

MR. FRANK SLATER: My experience has been somewhat limited as to the number of these joints in use, not having as large an experience as Mr. Gibbs. But the experience that we have had has been very favorable. We have had no expense connected with the joints after they are applied, when they are properly applied. On the first engine to which they were applied, the joints were placed considerably to the side of the engine, making the motion considerable when rounding curves, and they wore out very rapidly; they wore out in about six months. But all of them that have been placed directly in line with the drawbar show no wear to speak of, and I have every reason to believe they will last a long time. We have never been troubled from leakage. There is only one thing that is worn out on one set, in addition to the one I first mentioned, and that is the ball check valve, and that is a part which is very easily replaced at small cost. So far as the ball joint itself is concerned, we have had no trouble with those that were applied, as stated, directly through the center of the engine; but when applied to the side they will wear out rapidly, so that any person who has not had that experience might be disappointed if he did not apply them properly.

THE PRESIDENT: Will Mr. Manchester speak to the subject, please?

MR. A. E. MANCHESTER: Mr. President and Gentlemen,— Our experience has not been great as to numbers, nor has it extended over a long period of time. We commenced last fall applying Moran joints to a number of our passenger engines that hauled dynamo trains. We had been experiencing a great deal of difficulty with hose connections with the high pressure steam and the excessive motion, with our over-head system, between engines and tenders. The experience thus far has been entirely satisfactory with the Moran joint. We have had no failures whatever. There have been no cases of leakage. We are putting on some more of the joints at the present time, in this same class of service. The question of cost is considerable when compared with the hose connection, but after looking over our record of cost to maintain the hose connections, we came to the conclusion that it would be a very good investment. We found that it was costing us for hose in that particular class of service in dynamo trains, about ——, well we were using about seven or eight hose a year to maintain the service between the engine and tender, with occasional delays occurring on the road by reason of the failure of the steam, but with the flexible joints we believe that as far as we have gone, at least, they are very satisfactory. The joints come recommended in such a way that we get a three years' guarantee on them, which of itself is something of an object.

THE PRESIDENT: Are there others who have remarks to make on this topic? If there are, we would be glad to hear from them now.

MR. R. H. JOHNSON: Mr. President, while not having such an extensive experience as the gentlemen to the left have just claimed, we have been using steam heat for the last three years; we have had a trial of metallic pipes and their connections, and our experience has been just the reverse of that mentioned on the floor, because we find the joints wear out very rapidly. They were placed, as the gentleman on the left mentioned, on a line with the center of motion, to prevent as much as possible all lateral motion. Another feature of the case we found was the condensation, and so much lateral motion of the pipe fore and aft, that it was hard to keep it covered; consequently we could not govern the condensation as well as we could wish, although in speaking of this subject I would mention that we do not use a dynamo; consequently we have simply to heat about seven cars

in the train, and a dining car, making eight. Our experience with the hose has been very unsatisfactory.

MR. F. M. WHYTE: Perhaps Mr. Johnson's difficulty comes from not attending to the joints during the summer. They need quite as much attention during the summer, when they are out of use, as in the winter, when they are in use, and even more.

MR. R. H. JOHNSON: I would state for the gentleman's information, that we remove them as soon as the thermometer guarantees anything like pleasant weather.

THE PRESIDENT: If there is nothing more to be said we will close with that topic and proceed with topic No. 1. But before we do that I have this notice to read. This is an announcement of the Committee on Correspondence and Resolutions. I have the pleasure to announce the following as that committee: R. H. Soule, A. E. Mitchell and John Hickey — a very excellent committee, and they will report at the last session of the convention. The first topical question is: "To what extent and with what success have the recommendations of the Committee on Exhaust Nozzles and Steam Passages been adopted?" Gentlemen, you will please note the language there. It is not, What you are doing in other lines, but to what extent and with what success have the recommendations of the Committee on Exhaust Nozzles and Steam Passages been adopted. Mr. A. L. Humphrey will open the discussion.

MR. A. L. HUMPHREY: Mr. Chairman and Gentlemen,—Just before leaving home I received word from the Secretary saying that this subject had been assigned to me, and asking if I would open it. While I had decided views on the question, I desired, for the benefit of the Association, to make the subject as broad as possible. I therefore addressed letters to thirty members of this Association, including some of the most important builders, asking their experience and asking that they reply here at this hotel. After arriving here, I am glad to say that I found, quite contrary to the general rule, twenty-four replies out of the thirty, which very much encouraged me in this work. Among the twenty-four replies were three from the principal locomotive builders of this country. One of them replied that they had not received very much encouragement from their patrons in regard to this device or method. The next to the largest, I might say, replied that their patrons had almost universally adopted the method, which indicates its success. The third replied practically

the same as the second. The replies indicate that the practice is becoming almost universal. I might say, however, that there are some slight modifications or alterations in different sections of the country to meet local conditions, but I found the members agreeing with me very largely that this particular part of the locomotive was, in their opinion, paramount to any other. It is through the device under consideration that the saving of fuel is brought about, that the work of the locomotive is bettered. We find that by increasing the steam passages and arranging them as has been recommended that we do away with the back pressure to such an extent as to give freedom to the locomotive, which is of great importance. We find that by the arrangement, as so wisely suggested by the committee, we have a softer exhaust, so that it does not work so severely on the fire, and at the same time permits of an easy, free steaming engine. By working the soft exhaust it makes it easier on the tubes of a locomotive, easier on the fire box, easier on the fireman's back, if you please, which means considerable in the saving of the coal pile. So I believe I can say, without fear of contradiction, that among the several recommendations that have been made before the conventions in the past, none have been more universally adopted and with greater success than the recommendations made by this committee in the 1897 proceedings. (Applause.)

THE PRESIDENT: Gentlemen, any further remarks on this topic?

MR. QUEREAU: To keep the ball rolling, I would like to make a few remarks. In connection with this subject, before another Association I have received twenty-one replies from a number of railroads in the United States and Canada, and of that number there are seven roads that do not use the Master Mechanics' design; four report that the Master Mechanics' design is not as good as their standard exhaust pipe and front end arrangement; four report good results, but no marked improvement; six report a decided improvement. In this connection it might be well to note that the majority of these replies were received from railroads which are commonly called small, and not from the large trunk lines, although some of them are represented. One superintendent of machinery says: "We are receiving better results from the Master Mechanics' exhaust pipe than any we have used." Another says: "The result has been that our locomotives can be made to steam much better, that a larger pipe can be used than heretofore, and there seems to be a fuel saving, although

we have as yet no data as to this." So far as the Denver & Rio Grande is concerned, we have twenty-five locomotives on the first division equipped with the Master Mechanics' design of exhaust pipe. One very important result has been that our firemen have discovered that they can not make steam with this design if they are sluggards—a term which I think will be appreciated, and consequently some firemen can make engines steam properly, save coal and use a larger exhaust tip with the Master Mechanics' exhaust pipe, which is 22 inches high on the engines to which I referred, as compared with the previous standard which was 14 inches high. As a result, there is considerable interest developed among firemen, and although so far there has been no marked gain in fuel economy there has been a gain in the increase of the diameter of the tip and an interest developed both among the firemen and the engineers — which is equally important or more so. I would be glad if any one here who has had similar experience to ours with engines on which these tips are used would let us hear from him. We get the baffle plate, the lower edge of the baffle plate, or movable diaphragm, 10 inches above the top of the exhaust pipe. Because of this arrangement we find some complication. If any one has had similar experience I should be very glad to hear it.

Although I may be somewhat out of order in making the following remarks, I will assume the responsibility of doing it. It is very appropriate in this connection. Some of you possibly know that a reporter has been appointed for the International Railway Congress which meets in Paris in 1900 to prepare a report for the 1900 session on exhaust pipes and front end arrangements. Circular letters to the number of 125 have been sent out to the Superintendents of Motive Power of the principal railroads of the United States, Canada and Mexico. Of those 125 circular letters just twenty have received the courtesy of a reply. It seems to me very important that American practice should be very fully represented in this report. We are inclined to presume, and I believe on good ground, that American practice is leading the world in locomotive design, possibly not on this particular part of the locomotive, but that can not be established either one way or the other unless American practice is very fully represented. For your information I would say that this report is supposed to be in Brussels, September 1 of this year. In order to reach that point on that date it should be mailed not later than August 10, allowing for delay. If American practice is repre-

sented as it should be, and it seems to me that it is well worthy of the fullest representation, it is advisable that these replies be mailed very promptly to the reporter, as it will take considerable time to compare the results, tabulate the figures and prepare a proper report, which I am sure all of you would wish should be made as representing American practice.

THE PRESIDENT: Gentlemen, I will not be able to allow you all as much time as I have allowed Mr. Quereau, but I think his remarks are to the point and I hope that you will think about it and reply to him as soon as you can. Are there any other remarks on the subject?

MR. FRANK SLATER: I believe I understood the last speaker to say that the bottom of the baffle plate was ten inches above the top of the tip of the nozzle?

MR. QUEREAU: Yes, sir.

MR. SLATER: In most cases that would expose nearly all the flues, and it is a mystery to me how he can keep the front end clean with an arrangement of that kind.

MR. MILLER: In 1896, after twelve years' service in another department, I returned to the mechanical department, and the first thing I discovered was that we were not getting as good results from our engines as we ought to. I looked around to see where the remedy was. I found that a committee of the Master Mechanics made a report on that very subject, and I made a trial of it at once. I would not say I have always followed that, because I have made some experiments since, but in almost every case I have returned to the Master Mechanics' recommendation, and it is standard with the Michigan Central road today. I think I have got about twelve old diamond stacks on the road and I will get them off as soon as I can. (Laughter.)

MR. MCCONNELL: We will take them.

MR. JOHNSON: Referring to the remarks of the gentleman on the left, I would say there was a part of the question left out by him. As you are all aware, coal varies in weight as well as in its disposition to break up into small cubes. Now, sir, as brother McConnell said at one of our previous meetings, for one kind of coal you assert certain facts and you arrange your nozzles, netting and stack to conform. There are other conditions with lighter qualities of coal, and it is necessary to have different sized nozzles and a finer netting. All

those things should be taken into consideration. There are many roads in this country who do not live directly up to the Master Mechanics' recommended practice, from that very fact. Consequently, while they may differ from the recommended practice, it could be better explained if the fact were brought to notice that the coal was such as required the change.

THE PRESIDENT: Gentlemen, if there are no further remarks on that topic, we will proceed to the next question.

MR. QUEREAU: I wish to say for the information of Mr. Slater that on account of the extreme height of the baffle plate on the Denver & Rio Grande engines we do not care to clear the front end so long as we clear the bottom flues; let her fill up if she wants to; the exhaust and the draft are all the better.

THE PRESIDENT: Might it not have an effect on the draft and the combustion in the fire box if you were to lower it down?

MR. QUEREAU: Possibly.

THE PRESIDENT: That is our experience, and I merely make that as a suggestion.

MR. QUEREAU: That it is an improvement to drop, Mr. Chairman?

THE PRESIDENT: Yes, sir, we found it so.

MR. QUEREAU: Well, that is what I was seeking light on.

THE PRESIDENT: Topic No. 2: "Has not the time arrived when air-brake instructors can accomplish more by instructing those who maintain brakes how to maintain them than to instruct those who use them how to use them?" Mr. William Forsyth was to open up this subject, and he is not with us today. I hope that some one will feel free to take up this subject and start it? Who will be kind enough to do that?

MR. SINCLAIR: Mr. President, if you will let me suggest, I would propose that Mr. Bayley, of the Westinghouse Air-Brake Company, be requested to open that discussion.

THE PRESIDENT: I beg your pardon, Mr. Sinclair, for a moment, but I have an announcement here. Owing to the fact that we are to be favored with an address by Captain Evans tomorrow morning, the meeting will be held in this room. Bear that in mind. Mr. Bayley is not a member of the Association, but if the convention wishes

to accord him the privilege of the floor, we should be glad to hear him.

MR. JOHNSON: I move that the privilege of the house be accorded to Mr. Bayley.

The motion was carried.

THE PRESIDENT: Mr. Bayley, we will be glad to hear from you.

MR. BAYLEY: I thank you very much for the courtesy. Mr. President and Gentlemen, I think it very proper to teach both sides of the house in the matter of air brakes, not alone how to repair them but how to operate them. There are those who have to maintain them and there are those who have to operate them, each of them occupying a different sphere. We take the inspector and tell him how to repair them. We do not bother to tell him particularly how to operate them, because he is not in position to do that. The engineer and the fireman, on the contrary, we do tell how to operate them; while it would be useless, as a rule, to tell them how to maintain them, because they are not required to perform work of that character. This course of instruction is carried out in our air-brake instruction car — namely, the engineer is taught to manipulate the brakes, while the inspector, on the contrary, is taught to maintain them. To add to the instructions of the engineer how to maintain them, or to those of the inspector how to operate them, is an entirely unnecessary proceeding and is a waste of time. I might say here incidentally that we are always glad to have your inspectors, or for that matter, any other of your employes who have to do with either the maintenance or operation of brakes, come to our works, and I therefore heartily extend to you all, and to all railway men who are interested in this particular line of work, an invitation on behalf of the Westinghouse Air-Brake Company to visit our works at any time they may see fit, and we will be very glad to give them any desired information which will extend their usefulness. I thank you for your attention.

MR. J. F. DEEMS: I am not sure that I understood Mr. Bayley correctly, neither am I quite certain that I understand what is contemplated by this question. But if it is the idea that the instruction shall be confined to those who maintain the brakes, then any tendency toward a let-up, so to speak, on those who use them I think would be a very grave mistake. It should be remembered that those who use the brakes are constantly changing, the men are coming and

going. Not only that, but those who are using the brakes daily from time to time overlook quite a good many things that are given to them by the instructor, and it seems to me quite important that their memory should be refreshed by periodical visits from the air-brake instructor, and it seems to me any disposition to reduce the number of the visits from the air-brake instructor or that the air-brake instructor should in any way relax his vigilance among those who use the brakes would be a very dangerous experiment.

MR. J. L. LAWRENCE: I think we ought to feel somewhat sorry for the air-brake inspectors who have the task of instructing those who maintain brakes, for this reason: I think you will find on the majority of railroads that the class of men who have now to deal with the intricate parts and the maintenance of brakes are practically the same class of men who maintained incidental freight car repairs before air brakes were known. Those men, with all due respect to them, are more or less illiterate; they have never had much experience, and their caliber is a little too narrow for them to grasp some of the problems of air-brake maintenance today. In other words, I think that we should look for a partial solution of this question by placing, wherever an opportunity presents itself, better men, even if we have to pay them better wages, to maintain brakes. I for one would be very sorry to see the air-brake instructor taken away, either wholly or partially, from those who operate brakes, and to have him give his attention to those who maintain them. We must assume that the brakes go into service in proper condition. If they do not, it is really not the car inspector's fault; it should come back to the motive power department. Consequently, if the brakes go out in proper condition, there is no reason why they can not be operated in proper condition. But I do not think it would be advisable at this time to take the air-brake instructors and put them into the shops — practically take them off the road, if that is what it means.

MR. JOHNSON: I opine that what is contemplated by topic No. 2 is to get a better system in the repairs of air brakes, and naturally their maintenance. As every one knows, in our line of business, for the last ten or fifteen years we have spent considerable time and patience instructing engineers and those in immediate charge of air brakes how to get the best results, until today in nearly every town of importance you have a school, and engineers, firemen, brakemen and conductors are generally members of that school. Consequently

they are, if such a thing is possible, overtaught. While it is a fact that air brakes have increased fully thirty per cent on our cars lately, we have added but very little to the opportunity given to repairers to learn. In many yards today there are no means of testing train brakes. If an instructor was to go there and give his attention and arouse as much enthusiasm in the shops and among the air-brake repairers in the yards as he did some years ago in the service where they are in use, I believe it would be a great advantage to the Association and to the air-brake service.

THE PRESIDENT: Gentlemen, we have with us Mr. Huntley, of the C. & O., and Mr. Conger, of the Traveling Engineers' Association, and I would like to hear from those gentlemen, if there is no objection. If there is none, Mr. Huntley is accorded the floor.

MR. HUNTLEY: This is an honor as well as a surprise, to be called before a body of men of this character to give an opinion on so important a subject. I must say I would rather have had opinions from more of you gentlemen, in order to get more detailed information before speaking on the question. The only thing that I can say in reference to the management of air brakes, whether in repair yards or by trainmen, is that strict vigilance is most essential. As I understand the question before this body, it is not so much taking the time of the air-brake instructor away from the enginemen or the conductors, as it is to give a little larger proportion of time to the inspectors. With our road, handling long trains, working all air brakes, we find from experience that we must of necessity get down to the inspectors if we expect to get results. I cannot class our inspectors, gentlemen, as a body of men not capable and not ready to learn, because I find when I go to them and give them the points, that we get good results. So far as the enginemen are concerned, I agree with the gentleman on this side who spoke in reference to little pettyisms liable to spring up at times, not from the knowledge that they have of the brake, but from carelessness. You must work the two together. The time may be when we must take specially the repairs under consideration. As to that I am not prepared to say; I leave that for gentlemen who are versed in matters of that kind; but it would seem to me as a necessity that the two must go together. The road that I have the honor to be connected with thinks we should give more attention to the inspectors at the present time. Local conditions would govern. I thank you very much for your attention. (Applause.)

THE PRESIDENT: Mr. Conger.

MR. CONGER: Mr. President, I do not know that I have anything to add to Mr. Huntley's remarks. I fully agree with him. We have both been through the same school of air-brake instruction and possibly air-brake superintendence, and I have found that the question of air-brake maintenance has been left to the last, and one of the greatest difficulties that we have had in instructing enginemen is to get them to understand how to do good braking with poor material. As an instance of how poor the material can be, I was on a mountain road some two or three weeks ago with some air brakemen who were testing the method of controlling trains down heavy grades without the assistance of the hand brakes. A careful canvass of the brakes was made and we found that about forty per cent of the brakes on a train of twenty-eight cars could be classed as in good order throughout, pressure retaining valves and all; that is, when we got to the bottom of long grades the wheels would be warm. Now what was the matter with the other sixty per cent? Simply a lack of maintenance. There are so many things going wrong with the air-brake equipment which can be easily attended to by the car repairers on very short notice, if they only knew just where to look for it, that it seems surprising to the air-brake instructors sometimes that more attention is not paid to it, and I think it looks like the sunrise of air-brake perfection when we find the Master Mechanics' Association is commencing nearer the bottom by instructing the men who have charge of repairing the air brakes, who inspect them as they inspect the rest of the cars, and go no further, because they are ignorant of just exactly what to do. In my experience with air-brake matters I have found that the car repair men, as far as is necessary, are just as easily instructed as the enginemen. I speak as an engineman, for that is my profession. (Applause.)

MR. BARR: Mr. Chairman, I think we have had a very good illustration just now of the value of our action this morning in indorsing some of these other associations. I do not believe that there is one member of the Master Mechanics' Association in a general Master Mechanic's position who could talk as well to this point as these two gentlemen have. They have said something which is worth more, I believe, than almost anything any of us could say, and I think that in our actions those two associations ought to be recognized as well as the others. (Applause.)

MR. SMALL: From the way in which this question is worded it would seem as though it was contemplated that the Association should take some action. It reads: "Has not the time arrived when air-brake instructors can accomplish more by instructing those who maintain brakes how to maintain them than to instruct those who use them how to use them?" I would, therefore, move that it is the sense of the Association that the time has not arrived when we can abandon the instruction of those who use the brakes; but that it is very proper that more care should be given to the maintenance of brakes than has been done heretofore. On our system we look to the road foreman of engines more particularly to instruct the enginemen in the use of brakes. That is, men are selected by the road foremen who are experts in the handling of trains on mountain grades and other places. The sole duty of the air-brake instructor or inspector who goes over the road into the different shops is to see that the men who repair brakes, cocks, triple valves, etc., conform to standard usage and that the same men are employed in such work. I would make that as a motion. I think that some definite action should be the conclusion of this discussion. (Seconded.)

THE PRESIDENT: The Secretary will read the motion.

MR. CLOUD: The motion is that it is the sense of this convention that the time has not arrived when we can abandon instructions to those who use the air brakes, but that the time has arrived when we should perhaps take more care to instruct those who repair the brakes and keep them in order.

The motion was carried.

THE PRESIDENT: That disposes of this subject. We will take up the next topic, No. 3: "The best arrangement of flanged and bald tires on ten-wheel locomotives to secure the least wear of tires and rails." Mr. G. R. Henderson will open the discussion.

MR. HIGGINS: As chairman of the committee on the use of flanged tires I would like to suggest that this discussion be deferred until that report has been read, and let the topical discussion follow the report. I think it would save some time.

THE PRESIDENT: If there is no objection, the chair will concur in that suggestion. We will proceed to the next topic, No. 4: "When double-headers are used on passenger or freight trains, is it good practice to cut out the brakes on the head engine, and does this

comply with the requirements of the law?" Mr. T. R. Browne will open the discussion.

MR. BROWNE: As far as I am concerned this appeals to me more as a transportation question than one with which I have directly to do. It was assigned to me last year and postponed. I have not been able to determine that there is any particular law governing what disposition shall be made of this division of the ability to apply the brakes to the trains. On the Pennsylvania, the provision at the present time, I believe, is that the head engine or leading engine in passenger double-headers, and to a certain extent in freight, shall do the braking, and except as to the application of the emergency, the second engine, or the engine next to the train, shall be cut out. This condition is somewhat altered on the mountain divisions, where double-heading is used for a short distance only, and under those circumstances the engine next to the train controls and applies the brakes. There is hardly any necessity for applying the brakes, however, in going uphill. As to the advisability of this matter I do not know that I could state that from my own experience. It would appear to me, however, that the head engine being in the lead, and assuming, of course, that the crew of the head engine is acquainted with the road and the signals, should have the ability to apply the brakes as well as the second engine. It seems to me that to cut out the head engine entirely removes to a certain extent the possibility of a feeling of responsibility on the part of the crew, and throws it all on the engine behind, and from the standpoint of my limited experience and my ordinary judgment in the matter, I would naturally feel inclined to say that both engines and both crews should have it within their power to apply the brakes, especially on double-headers, which usually means a heavy train, and in case of grade.

MR. JOHNSON: If no one else is interested, I would say from practical experience I had on the Jackson road, that the cutting out of the engine here means simply the brakes — not the power of operating the brakes on the train. I had a little experience in double-heading where the hose pulled off between the engine and tank of the leading engine that I was running, which applied the brakes instantly, and made a dead stop or block of the front engine, and did considerable damage to the platform. After that they would not run any more double-headers. On other roads on which I have seen them operated, they would cut out the brakes on the drivers and tenders, but leave the brake operation in the hands of the front engineer.

MR. QUEREAU: I draw the same inference from this question that Mr. Johnson does; that is, that it refers to the braking of the wheels on the engine rather than the cutting-out of the engine and the engineer's valve. On the Denver & Rio Grande, because of several occurrences where the driver brakes were on both engines, the head engine broke loose from the rear engine, parting the hose, and the brakes were set in emergency at once. The rear engine had the whole train with its inertia behind it, and its less braking power, and what we call a few jacks, that is, non-air cars at the rear. The result was that both engines were very severely damaged. So that the present practice with us is to cut out the driving brakes on the forward engine, but leave the control of the brakes on the entire train with the forward engineer. Then in case of a break-in-two the braking power of the head engine is of such a small extent that there is less chance of danger. I do not know whether that is the law or not, but it is our practice.

MR. A. W. GIBBS: What I think Mr. Browne did not clearly state was that the arrangement of the engineer's valve, which he mentioned, permitted the engineer of the rear engine only to apply brakes. It was expressly arranged that he should not be able to release the brakes, for the reason that should the forward engineer discover the necessity of applying the brakes, while the engineer of the other engine had left his brake in a release position, the result would be a brake failure. Therefore, the brakes with us are so arranged, with double-headed passenger trains, that the forward engineer has control not only of his own brakes and the train brakes, but also those of the rear engine, the rear man not having the power to release.

THE PRESIDENT: I think that closes that topical discussion. It is one o'clock. We will take up now our regular subjects. The first one is, "A research laboratory under the control of the Association." Mr. G. R. Henderson is chairman of that committee and will present the report.

MR. HENDERSON read the following report:

REPORT OF COMMITTEE ON A RESEARCH LABORATORY UNDER THE CONTROL OF THE ASSOCIATION.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee begs leave to submit the following arguments in favor of such a laboratory.

1. *The Need.*— Each succeeding step in the development of a science broadens the outlook. When the facts which bind one condition to another have been fully ascertained, they immediately become stepping stones to new facts, suggesting new conditions, and giving rise to new questionings. Each achievement is a demand for new effort. The process is one of perfecting and has no end. Moreover, the problems arising in this process become more and more difficult as the work proceeds. Not only, therefore, is each achievement a demand for increased activity, but for more perfect methods as well.

The preceding general statements, applicable to the development of any science or art, are especially true of those branches of engineering which are represented by this Association. The past has had its problems; they have been met with masterful energy and many of them have been solved. Facts thus discovered give direction to present practice and constitute the promise of better things to come.

The most significant results which thus far have been presented to this Association are those which have been derived from carefully conducted experiments and study, a process which for the purpose of this report, will hereafter be referred to as *research.* These, while they have benefited all roads alike, have been obtained as the result of personal sacrifice on the part of comparatively few members, and at the expense of a few roads.

The establishment of a research laboratory by this Association would be proof of its readiness to adapt itself to the demands of more exacting conditions, and would show in a fitting manner its sense of fairness in requiring contributions from all who receive benefit.

A further argument in favor of an aggressive policy in line with the suggestions of this report is to be found in the practice of many of the larger manufacturing establishments in setting aside a certain percentage of their net earnings to be spent each year in betterments. There is profound wisdom in the principle which, as stated by a manufacturing member of this Association, is, "For every dollar earned, a manufacturer may put 50 cents in his pocket, the other 50 cents must be used to improve methods — it does not belong to him for his pocket." It is this progressive spirit that has given our manufacturers their enormous productive power, increased the quality of their output and reduced its cost, and made, in a few decades, the farm-country of America a manufacturing nation which today is unrivaled by any nation in the world.

It is not intended to imply that the management of American railways ignores this principle; such an implication would not be true so far as it applies to many of the larger questions which are involved, but it is true in its application to many roads with reference to the details of some departments.

2. *A Measure of the Problem.*—At the present time there are in the United States, in round numbers, 36,000 locomotives, 33,000 passenger equipment cars,

and 1,230,000 freight cars. These are probably worth nearly $900,000,000. In keeping this rolling stock in repair, there is spent in the neighborhood of $60,000,000 per annum, not including lubrication and such maintenance. It is thus seen that the value of the equipment and the annual charges for repairing it call for a great outlay of money, and yet there are thousands of points and questions in regard to the design of railroad cars and locomotives which should be cleared up, and upon which valuable (having a cash value) information could be obtained by the proper investigation, conducted in a thorough and reliable manner. One-tenth of one per cent of the amount paid out yearly for keeping up the condition of the equipment would provide a handsome sum for the purpose of conducting such investigations as have been outlined above.

The combustion of sixty million tons of coal each year is no small undertaking, but the payment for the same is a still greater one. Even one per cent (a value so small in a comparative test that it is disregarded) of the quantity would be one-half million tons! And there are hosts of inventors who claim that their productions will save many per cents. These suggestions are merely intended to emphasize the desirability of scientific examination into their merits

There are, of course, many directions along which the spirit of improvement may manifest itself; the present purpose is to urge the adoption of more extensive and equitable methods of developing such scientific facts as are needed to stimulate the deliberations of this Association, which, officially, is charged with the responsibility of maintaining the equipment of 200,000 miles of American railway, and to guide the practice of its members.

3. *The Plan.*—The committee makes no plea for the details of any plan of organization, but to give definiteness to its argument presents, in the form of an appendix, an outline prepared by one of its members, of the more important features of a plan which appear to be fundamental and safe.

Reference to the appendix will show that a large initial investment is not thought necessary, the use of existing laboratories being proposed rather than the immediate establishment of a new plant. Such a plan appears to your committee not only wise, but it is one to which the Association, by its past practice, is already committed. By selecting one laboratory for one line of investigation and another for a second line, the co-operation of men and materials best suited to the needs of the Association would be secured.

4. *The Cost.*—The cost of organizing and maintaining such a movement, even on the limited scale proposed, would be considerable. Within limits, the results are likely to prove beneficial in proportion to the money which is put into the work. Great returns are not ordinarily expected from small investments. To insure a degree of success which will comport with the dignity of the society, the proposed organization should be assured of existence for at least three years, and money for maintenance during this period should be in sight. The *minimum* amount which your committee deems necessary for a period of three years is $40,000, of which $12,000 should be available during the first year, and $14,000 during each of the two succeeding years. If more could be provided, the returns would be still greater. During the period of assured existence the research laboratory may be relied upon to justify its existence to an extent which will thereafter be the means of supplying whatever may be neces-

sary for its proper conduct. If it were to fail in this it would be time to stop expenditure.

5. *Routine Work.*— It is likely that the existence of an organization for research would lead to work of a routine character, such as examination of water, chemical and physical tests of materials, etc., for individual roads, especially for smaller lines which do not now maintain laboratories nor have engineers of tests. If undertaken at all, the cost of such work should be paid for by parties receiving benefit, and could, therefore, be self-supporting. Routine work, however, should not be undertaken at all along lines in which private laboratories are prepared to give satisfactory service at reasonable cost, for such work is distinctly less significant than that of research. The one may serve to keep practice up to known standards, but the other is the basis which serves to advance practice. A research laboratory, therefore, should not be drawn away from its high calling by the allurements of minor interests.

6. *In conclusion*, that the matter herein presented may receive proper consideration, your committee would recommend the passage of the following resolution, to wit:

Resolved, That in the opinion of this Association there is need of more concerted action in the development of such practical and scientific facts as are needed to direct practice in the design and maintenance of railway equipment; and,

Resolved, That the Executive Committee be and hereby is directed to carefully consider the plan for a research laboratory under the direction of the Association; and is authorized to formulate a plan of organization; to ascertain by what methods the necessary money can be assured; and, so far as may be practicable and expedient, to proceed with the actual work of organization; also,

Resolved, That in case the Master Mechanics' Association should become merged into, or consolidated with, the Car Builders' Association before action is taken under these resolutions, the persons who at the close of the present convention represent this body in an executive capacity, be and hereby are authorized and directed by this body to present the whole question covered by these resolutions to such Directors or Executive Committee as may hereafter represent the interests which are now intrusted to the care of this Association or of the two associations named; and be it further

Resolved, That it is the desire of this body to have presented a report of progress at the next annual convention of this Association, or at the next convention of such association as may one year from date represent the interests of this Association.

G. R. HENDERSON,
W. F. M. GOSS,
JOHN PLAYER,
Committee.

APPENDIX.

A POSSIBLE PLAN FOR THE ORGANIZATION OF A RESEARCH LABORATORY UNDER THE CONTROL OF THE ASSOCIATION.

A research laboratory does not necessarily involve extensive equipment, nor large initial investments. It would, in fact, be wholly impracticable to equip at once a laboratory which for several years to come would be suited to the needs of

this Association. Research is inquiry, and inquiry leads to new fields of action. Each new investigation is likely to require apparatus of a form not before dreamed of. For example, an investigation concerning the action of triple valves brought a testing rack, and another, with reference to the behavior of brake shoes, brought the Master Car Builders' brake shoe testing machine. It is in a similar manner that nearly all of the apparatus constituting the equipment of a railway research laboratory must be brought into existence, and, consequently, what shall constitute such an equipment can only be told after the problems to be investigated have been settled upon.

The first requisite to the establishment of a research laboratory is an organization of men. Everything hinges upon them. The more broad-minded and the better prepared the men, the more significant and lasting will be the results derived from their work. Such an organization could, by using existing laboratories, accomplish results which in their importance would be great out of all proportion to their cost. There are in round numbers fifty institutions of learning in this country having laboratory facilities for experimental work more or less extensive. The equipment of these laboratories is employed by the school authorities but a small portion of the time. Any of these institutions will gladly permit any authorized representative of such an organization as the Master Mechanics' Association to use its apparatus for the general good, and in many cases they will be found ready to contribute the time of assistants. The one thing which the Association would need to supply is *direction*. The school authorities do not ordinarily have time to study problems outside of their usual routine, or which are not of their own choosing, but if such an association as ours can supply the initiative, they can as a matter of routine do very much to advance any line of research. By securing the co-operation of such laboratories as may be suited to its need, and by supplying directive force, the Association can in many cases have results for the cost of supervision.

A research laboratory under the control of the Association should involve conditions which, briefly, are as follows:

1. All matters growing out of or affecting the research work should rest with the Executive Committee of the Association.

2. There should be appointed by the Executive Committee a Director of Research, with whom would rest the appointment of such assistants as from time to time might be necessary. The Director should be responsible to the Executive Committee.

3. The organization for research would not affect the present method of assigning subjects to committees, but the Director of Research would serve the committees when called upon to do so.

4. The method in detail would probably work itself out about as follows:

A committee having been assigned a subject would outline its plan of work, and fix the limits of its investigations. If the subject is one requiring research, it would define its problems for the guidance of the Director of Research, who, with the approval of the Executive Committee, would proceed in its development, always under the immediate direction of the committee in charge of the subject. If apparatus already in existence is required, the Director would endeavor to have it made available. If new apparatus should be needed he would, with the approval of the

committee, produce it. If road experiments were involved, he would find a place where they could be had; and if the opinion of specialists in any line should be required, he would be expected to know whom to get. The Director of Research would, in fact, be a kind of chief of staff to the working committees; a connecting link between the realm of practice, as represented by the Association, and the realm of science. The investigation over, the Director would report to the committee having charge of the work, which committee would formulate its report to the Association, which generally will contain a summary of the facts presented to them by the Director of Research.

5. The Executive Committee would be responsible to the Association for the expense entailed by investigations instituted by the working committee, and for this reason no work should be inaugurated until an outline of the same, together with an estimate of its cost, should have received the approval of the Executive Committee.

6. While it is probable that the process herein suggested will, if vigorously followed, develop a permanent organization, it would seem wise, at least in the beginning, to call in special assistance to serve in the solution of special problems. It is possible also that apparatus would gradually accumulate, but in the beginning the laboratory would not need to be more extensive than the office of the Director, which would become headquarters for the laboratory.

7. To provide an element of permanency, a laboratory should, if once started, be assured of existence for a period of several years, otherwise everything would need to proceed on a temporary basis, which is never profitable in scientific research.

W. F. M. G.

A RESEARCH LABORATORY.

As the name indicates, a laboratory of the nature contemplated should be so thoroughly equipped as to be capable of conducting any and all kind of researches and investigations relating to railroad economy. The subjects referred to such an institution would be of the same nature as is now daily and constantly taken up by the railroad laboratories already established by individual roads.

Upon this assumption a research laboratory will have to be equipped not only for routine, but also for unusual work of any and all descriptions, usually referred to specialists, consulting engineers, physicists or chemists.

It must be unfettered and untrammeled by individuality or idiosyncrasies — that is, it must be so free from entanglements of any kind that no matter from whom or where orders are received, the work placed under its jurisdiction will receive active, earnest and unbiased treatment, and the truth only sought for, no matter what the case or circumstances may be. In other words, it is the middle ground between the road and its officers, the manufacturer and the road, the employe and the employer.

The results obtained from investigations must be given as they are found.

A laboratory founded on such broad principles and with unlimited scope for research will be of incalculable value to the Association and the roads its members represent.

To properly appreciate the actual scope of such a laboratory, a few general items will give an idea of how such a laboratory must be equipped.

SYNOPSIS.

Test of Metals — Physical, chemical, micrographical.
Tests of Building Material — Physical, chemical, micrographical.
Tests of Woods — Physical, chemical, micrographical.
Tests of Machines — Efficiency, power consumed, etc.
Tests of Locomotives — Fuel, water, hauling capacity.
Tests of Locomotives — Steam distribution efficiency.
Tests of Fuels — Physical, chemical.
Tests of Finished Structures — Physical.
Tests of Lubricants — Physical, chemical.
Tests of Electrical Apparatus and Appliances.
Tests of Illuminants — Chemical, physical and photometrical.

These items contemplate the entire scope of railway work, and to properly conduct such tests the laboratory must be equipped with all the latest appliances for such work. From the work that has already been done by the Master Mechanics' Association and which will have to be carried on from time to time as the art of railroading advances, it will be readily understood that the research laboratory will not only have to be equipped so as to carry on any tests that have been made and need revision, but must also be so equipped that original investigations can be carried on without waiting for special apparatus, with which most of our university and private laboratories are equipped. This contemplates brake tests, wheel tests, locomotive tests, and so on through the whole gamut of investigations being made daily all over the country.

Such a laboratory would be under the direct charge of the Executive Committee, and should have the following officers: A manager in charge, who shall direct all tests and report on same, assisted by a chief physicist or engineer in charge of physical tests; a chief chemist in charge of chemical tests. Under these men should be an ample corps of able and capable assistants.

As experience has shown in our railroad laboratories, a machine shop equipped with tools for making instruments or special devices would be an absolute necessity. This shop would contain machinery for working metals and wood. For fuel tests a battery of boilers and a large engine would be necessary. For physical tests this laboratory would have to be equipped with a number of compression and tension machines with capacities varying from at least 500,000 pounds to 10,000 pounds for heavy and light testing, torsional machines, oil-testing machines (similar to Franklin Oil Company's), brake-shoe tester, wheel and axle drops, wire-testing and cloth-testing machines, brake racks, air and hydraulic compression plants, locomotive-testing plant capable of receiving the smallest to the largest locomotive, stay-bolt testers, and such other special testing machines as are found in our railroad laboratories, machines for testing cements and mortars, dynamometer cars, tachometers, barometers, thermometers, a full set of electrical testing apparatus, standard gauges and templates, standards of form and size adopted by the Association.

The chemical section must be thoroughly equipped with up-to-date apparatus for all kinds of chemical investigations of all natures and descriptions.

A complete electrical outfit of engines, dynamos, storage batteries and instruments must be provided.

The laboratory would also have to be equipped with standards of length, weight and measures.

Accessory equipment would include pyrometers, calorimeters, microscopes, indicators, and such other instruments as are likely to be needed. J. P.

COST OF A LABORATORY.

While the report as a whole recommends the utilization of existing laboratories, which will reduce to a minimum the cost of the organization, it may be advisable to submit some figures showing the probable cost of a laboratory fitted for ordinary routine work, and a certain amount of the simpler processes in research. It would, of course, be impossible to give any idea of the cost of a laboratory for research alone, as certain lines would require apparatus which might be more or less expensive, according to the needs of the work under consideration. The writer has made an approximate estimate of a small laboratory comprising a brick building approximately 75 by 120 feet, 20 feet of the length of which could be two stories in length, the upper floor to be used as a chemical laboratory, and the lower floor as offices, drawing-room, storeroom, etc., the remaining space to be about 18 feet high and to contain the machinery for testing and experimenting. A small annex would contain the boilers and fuel.

The apparatus needed to commence work in a limited way (and which would have to receive important additions from time to time as occasion demanded) might be about as follows:

One locomotive testing plant, like that of the C. & N.-W. R'y, but arranged to suit a locomotive with five pairs of drivers, with tanks, scales, tracks, etc.

One 300,000-pound testing machine.

One 100,000-pound testing machine.

One journal and lubricating testing machine.

One torsional testing machine.

One 12-inch lathe.

One 30-inch lathe.

One milling machine.

One drill press.

One planer.

One slotter.

One small forge and fan.

One 50-horse-power steam engine.

One 75-horse-power boiler.

One air-pump or compressor.

Shafting, belting, etc.

Gauges, meters, and various apparatus for recording and measuring.

One complete outfit for chemical laboratory.

It is believed that this lot of machinery and building could be obtained and erected for approximately $50,000, and that the cost of operating and conducting it in a creditable manner would run from $20,000 to $25,000 per year. Of course, routine work could be charged for on a regular basis, but it is quite probable that this

would interfere seriously with research work, which should be the main object of the organization. Besides, the outfit above described would be far from being complete, and would need additions from the start. We think that it will thus be clear that there are many points to be made in favor of the arrangement proposed in the body of the report, and that the maximum results could be obtained by a minimum cost under the proposed scheme, without requiring the immediate outlay for building and equipment. The director would, of course, have to keep informed as to the best locality for conducting the various tests that were desired, and make arrangements for the prompt conduct of the same, but we think that the various colleges would, with their usual liberality, generously assist in the enterprise. G. R. H.

On motion of Mr. Sinclair the report was received.

MR. MCCONNELL: Mr. Chairman, before the discussion on this question takes place, I would like to offer a motion.

THE PRESIDENT: You may offer the motion.

MR. MCCONNELL: As the by-laws provide that the meetings of the Association should commence at nine o'clock in the morning, and in view of the fact that we are to have an address at ten o'clock by Captain Evans, I would move that when we adjourn today it be to meet at ten o'clock tomorrow morning.

The motion was carried.

THE PRESIDENT: We will convene tomorrow morning, gentlemen, at ten o'clock. Now the paper as read by Mr. Henderson is before you for discussion. It is a very important subject and one I think we ought to study and look into very carefully.

MR. SANDERSON: Mr. President, I read the report of this committee with a great deal of care and interest, but I cannot altogether agree with some of its recommendations, nor yet with its deductions. For instance, under paragraph No. 1 — The need; it seems to me, from my way of looking at it, that the need as elucidated there points toward exactly the contrary. The harder the experiments and the more difficult the process of development becomes, the greater is the need of the specialist. This is an age of specialists. A generalist is not of much use in several lines of work, to push forward the science and development of mechanics any longer. Now, no body, no committee, no man, no individual in charge of a research laboratory can possibly be a specialist with a specially trained mind and a keen peculiarity of his own in some particular direction, which is necessary to carry the work of development in scientific mechanics forward to further degrees of progress. I can not agree with the committee that the demands are for a general research laboratory to which we are all to

subordinate our work; in other words, practically say to them: "Gentlemen, here is the subject; do it, fix it, see what you can do with it." It seems to me that the demand is far greater for encouragement of special lines of work by men specially suited for it, so that the best-fitted men will advance the work along special lines in which they are most particularly interested.

Further, the committee states that the results have been achieved as the result of personal sacrifice on the part of comparatively few members. I do not think that any of the members who have achieved results recently consider that they have made a personal sacrifice. I think they must look upon what they have done as an honor, and it certainly has brought honor and reputation to them, and it is honor and reputation, as well as pecuniary results, that is the spur that men need to prompt them to do this work. All such would be very apt to be neglected and left undone if there were provided for the purpose a special research laboratory. The general officers would say, "Never mind that, let that go, leave that to the research laboratory," and individual efforts will very largely be nullified. Now, as an illustration, the committee goes on to show how much development has proceeded from the work of manufacturers. That is another argument for the specialist. They do not employ generalists. They have special men for their own particular line of work. Now with regard to the routine work, there I think, is a line that the railway Master Mechanics and Master Car Builders could work on with very great advantage. We have an Eastern Railway Association and a Western Railway Association to take care of our law troubles. It has never been said that they interfered with private enterprise at all. Nobody has ever raised that claim that I have heard of, and yet most of the railroads use it for their advice as to the value of patents, protection from claims for infringement, and so on. Why not extend that idea? Why not provide now for the analysis of material by chemical methods? The testing of material, physically, has become an exact science. Let us form associations of the same kind as the Eastern and Western Railroad Associations for routine work in testing and proving materials; organize it in something of the same way, so that the roads interested will pay pro rata. All the small railroads would then have the advantage of laboratory work at a stated charge, which would just cover the materials needed in a test, just as well as a large road. It does not necessarily mean that the large roads now equipped with laboratories shall give them up; not at all. But it gives all the smaller roads an

opportunity to follow out all the work in the same lines, buy the material on specification and have it tested, with the assurance that they are getting what they want. There is a line where I believe the associations can work together and effect a great improvement in the quality of the materials purchased, but I personally am against the formation of any such bureau or department as is recommended here for research. I think that ought to be left for the individuals best fitted for the purpose to push it along according to the trend of their own minds, and that the highest results will be achieved in that way.

MR. DELANO: Mr. Chairman, I have read and listened to this report with a great deal of interest, and it seems to me it is a very valuable contribution to our proceedings. I should also be in favor of adopting the resolutions which put the matter in the hands of the Executive Committee for further consideration and to report next year; but I am inclined to agree with what Mr. Sanderson has said, that the conclusions are a mistake. It seems to me that there is some danger of getting too great a centralization in research work. At the present time, something like seventy-five or eighty per cent of the mileage of this country is represented by ten or a dozen large railroad systems. Each one of those large railway systems has a more or less perfect organization for investigating and testing, and it seems to me that that is quite as few as there should be in a country of this size. I am constantly impressed with the fact, when I am visited by supply men, that it is rather a fortunate thing we do not all agree. A man comes to you with the argument that roads A, B, C and D are all using his device as standard; think it preferable to any other. The road I represent happens to use a different device. Perhaps there are one or two that agree with us. Now, I say to him, where would this fellow be that I am buying material from if we all agreed with you? There would only be one manufacturer of car roofs, one manufacturer of something else — if we all agreed. Now, I think it frequently happens that more than one man is right, even though they may have diametrically opposite views, and there is a chance that in centralizing this research work under one head there would be too great a centralization, for it seems to me that our presidents and vice-presidents and general managers would say either that we must in contributing to the support of such a central organization, defer to their opinions and their conclusions, or we must stay out of it. They would say, What is the use of your maintaining your research lab-

oratory and your engineer of tests, and all that, if we are to be at the expense of maintaining this central organization?

MR. SINCLAIR: This subject of establishing a research laboratory has been before this Association, more or less, for the last fifteen years. There was a very active crusade carried on in its favor at one time, and an effort was made to convert what was known as the Boston Fund into the nucleus of a laboratory. Those who favored that were very aggressive and very noisy, and you would have thought that the thing was going to be carried through by acclaim whenever it came to a motion. But every time any decided effort of that sort was made, the good sense of this Association came up so strongly that it was voted out of sight, and then it did not appear again for a few years. That has been the record of the thing in the history of the Association. With a great many other members of this Association, I can not see in what way it is the business of the Master Mechanics' Association to do anything in establishing a general laboratory of research. The other roads are not interested in that, because they already have their laboratories. There is no reason why the roads that have not laboratories should fail to have their material tested, for there are plenty of private firms perfectly competent, perfectly willing to do this work, and I think it will lead to a miserable failure if you go much farther in recommending the establishment of this laboratory and the collection of the great amount of funds necessary to do so.

MR. BARR: Men can make mistakes, and I think I am safe in saying that associations of men can make mistakes. We heard this morning in the opening address of some mistakes in the way of prophecy, etc., that some very important and prominent men in old England indulged in not more than about sixty years ago. I do not know whether the time is ripe for establishing a research laboratory. I do not think very much of the arguments against a research laboratory that have been made this morning. They do not seem to be grounded on a proper foundation. It seems to me, as far as I can learn, that one member wants to do this himself and give us all an opportunity of original research on our own cars, and another that different devices are used in different places, and they are all right; another that we have had this question up before and have voted it down. So have we had a number of other things up before that we have voted down and have taken a back seat afterward on those very

questions, and I believe that this really is one of them. I think that this committee has done a good work, but at the present time — I do not mean to flatter them — they are a little like Stephenson; they are ahead of their times. I think their time will come. I believe that a research laboratory of this kind will come. I do not believe that we are ready for it now. But I do not think that we ought to take the position that one of our English friends did about Stephenson's engine, which was that it would scare the horses and could not be used on that account. Mr. Delano says it is a good thing to have different devices. So it is, and this research laboratory would very likely establish the fact that if Mr. Delano is using one thing and I am using another, we are both right. I do not think for a moment that the research laboratory should go ahead and say you should all use — I do not like to mention names now — well, cast-iron wheels instead of steel-tired wheels, or that you should use Krupp steel instead of Midvale steel. I will not mention any more for fear that you may think I am getting personal; but I am not; it is simply an illustration. I believe that a research laboratory would do more than anything else to wipe out a certain narrowness of opinion on these points, and to establish the fact that while we all do not do the same, we are doing, under our circumstances, about what is right; and I believe that is pretty nearly true, although we make mistakes, and it would also establish the fact that when there is a decided advantage in all of us using the same thing, that we would have the necessary information about it. This is a subject really that is so big that it can not be discussed. As I said when I rose, I do not believe we are ready to go into it this year, but I for one am not at all prepared to sustain the position that it is a dead question.

MR. HENDERSON: Mr. President, if there is no one else to speak I would like to finish the discussion. Mr. Sanderson spoke of the fact that it would be very difficult to obtain a specialist who would be a specialist in all cases. Of course that is very true, and on page 5 it will be noticed that it is supposed to be the special duty of the director of research to know where different specialties could be tested with the greatest benefit, and as some places are better prepared or better equipped for such observation than others, it would be his duty to keep in touch with those different localities and to decide where different tests might be made. If attention were paid to the title, it would be noticed that it was especially stated that the subject was a research laboratory — not a routine laboratory. The committee had

no authority to make any plea in favor of a routine laboratory. I am very glad to hear Mr. Barr's remarks on this subject, because while it is very possible that we are not prepared to go into the matter at the present time, yet it will undoubtedly be taken up in the future, and I would like therefore to call attention to the resolutions on page 3, which, if the Association deem proper, might be seconded and passed, and in that case it would place it in the hands of the Executive Committee, by which it could be held over.

THE PRESIDENT: Excuse me, please, Mr. Henderson, what is that remark you made?

MR. HENDERSON: I say I would like to call attention to the resolutions on the bottom of page 3, and I think they will agree very well with Mr. Barr's remarks, if the Association sees fit to adopt these resolutions and refer them to the Executive Committee; and the Executive Committee, if it thinks we are too far advanced, could still keep the matter alive, so that it would not, as Mr. Barr suggests, be smothered to death at this time, but there would be a chance to revive it from year to year as the case might be.

MR. DELANO: I would make a motion that the resolutions be adopted as recommended by the committee. (Seconded.)

THE PRESIDENT: The motion is that the resolutions of the committee be adopted. All in favor of that will say "aye"; contrary-minded, "no."

The motion was carried.

On motion of Mr. McConnell, the convention adjourned until the following day.

SECOND DAY'S PROCEEDINGS.

The convention was called to order on Tuesday, June 20, at 10 A.M.

THE PRESIDENT: I am very glad, ladies and gentlemen, that we are assembled together this morning under such very favorable conditions of weather. I think it will be conducive to good health and to our enjoyment. I am glad that so many of us have assembled together for the purpose of listening to one who has been active, I might say, in our late war, as it has about passed into history already. As we observed yesterday, the boats gathering down below here were already being disarmored or getting their war paint off. We have with us today one who was actively engaged in the memorable victories that have been achieved by our Navy, one who has helped honorably to hold up the honor and pride of our country. We have taken a justifiable pride in all the officers of our Navy and Army who have held aloft the flag which is so precious to us and which means so much to every American citizen. We have one who is, I understand, full of valor, always ready to do what he can for his country, not looking upon self, but looking for the glory of this nation. It seems to me that if every individual would lose sight of self and try to uplift our country, we would be a better people, seeking less for self and more for the glory of our great and glorious nation. I understand, too, that with all the victories, and all the glory that has come to him, he has not permitted himself to be Hobsonized in any way. (Laughter and applause.) He is modest and retiring withal, as are all great men. I now take the pleasure, the great pleasure, of introducing to you Captain Evans, of the United States Navy. (Great applause.)

CAPT. ROBLEY D. EVANS: Ladies and Gentlemen,—Of course, you all know that making speeches is not my business; I was brought up in a very different line; but I think it is becoming to every naval officer to thank the people who are so courteous and good to us. Of course, it is not necessary for me to say to you that I appreciate the compliment of being asked to address such an audience, but it is very embarrassing when you feel that you can not tell such an audience anything — that they know more than you do — and I am quite sure that the men in this convention can not be told anything by me. But it may be useful to recall to you some few things that you may have forgotten, and that it is good for you to remember.

In 1882 I had the good fortune to be ordered as a member of what is known as the first advisory board for rebuilding the Navy. It was an awfully hot summer, and fifteen of us rather impatient spirits got together in Washington, presided over by Admiral John Rodgers, and when we looked the field over we found that we had not any Navy at all; that we were hopelessly behind, and it seemed hardly worth while to undertake to rebuild it. But we struggled along in the hot weather, and I shall never forget as long as I live the trouble that I caused in that small convention by proposing that we should build steel ships. I was the original steel man, and when I proposed that all ships in the future should be built of steel, Admiral Rodgers adjourned the board for three weeks to prevent a fight. (Applause.) That, you will remember, was not a great many years ago — 1882; this is 1899. At that time we could not make a steel plate in this country; we were buying gun tubes from England; the idea of smokeless powder was a thing entirely beyond anybody's conception. We had heard vague rumors of torpedoes that were to blow everybody up, made in England or Austria or some other place; but we absolutely knew nothing about a Navy — we had no Navy, and we were not apparently in a condition to build one.

Since that time I have had the pleasure of seeing American ship plates go away beyond anything abroad. I have seen American guns pronounced the best made in the world. I have seen American steel ships do pretty handy work when they were called upon. (Applause.) Gentlemen, most of this, if not all of it, is due to the very men who are here today. You are the representatives of the people who did all this. We made the demand on you, and you filled the bill, and I feel quite sure you will always do the same. I am not certain that in the future we will not ask you to give us engine runs by liquified air, and maybe flying machines — I don't know what not. But I am sure you will do it; whatever we want you will be certain to give us.

I suppose naturally you would like to hear from me something about this late war; but I feel that I must keep a very strict guard on my tongue for fear that I might say something that would offend somebody. (Applause and laughter.) I do not mean that I would offend any of you, because you are all my friends, I feel that, and it would be hard to offend any of you. Therefore I would ask the gentlemen who are representing the newspapers here, if there be any such, to be very kind to me and not put down any ugly sentences; if I utter them please scratch them out. (Laughter and applause.)

When the war with Spain was threatened I was fortunate enough to be in Key West. I was in New Orleans when the Maine was blown up, and I was satisfied from the sort of roar that you could hear wherever a crowd of people came together that morning that we were going to take it out of the Spaniards sooner or later (applause), that nothing could stop it, and that the Congress of the United States was perfectly helpless; that the people of the United States meant to fight about blowing up the Maine. We had cause enough before that, Heaven knows; there had been women and children enough starved to death, almost in sight of our shores, to make the American man fight; but a wise-headed President, who is a very cautious man, and withal a very firm one, made up his mind that he would not fight until he was ready, and when he was ready he did it in good shape. (Applause.)

We were on a peace footing in the Navy. In fact, the whole country was on a peace footing. But I am afraid that in the Navy we rather deceived you about the peace-footing business. The difference between a peace footing and a war footing is a little curious to those who do not understand it. On a peace footing we go to quarters at night, with the guns ready to fire in three minutes, and when we get on a war footing we do it in two minutes and a half. (Applause and laughter.) We were on a peace footing in April of last year. We were lying off Key West, all very peaceable, but we had plenty of ammunition, plenty of coal, plenty of food, and we had lots of men, good North American chaps, behind the guns. (Applause.)

On the night of April 21, we were all assembled aboard Admiral Sampson's flagship off Key West, a very rough, nasty night. The Admiral was anxious to know what we were to do the next morning. Several of us, after waiting until eleven o'clock, proposed to go back to our ships. Admiral Sampson said, "Sit still and smoke another cigar; we must have some news from Washington in a few minutes." So we lighted fresh cigars and sat smoking. In a moment an orderly came in and said: "A torpedo boat coming, sir, very fast." In a few minutes the message from the torpedo boat was received, and it was very short, somewhat like a lemon. It read, "War declared. Blockade the coast of Cuba from Bahia Honda to Nuevitas. Issue proclamation of blockade." That was half-past eleven o'clock on the night of April 21. At twelve o'clock I went back to my ship, and at that time I could see the searchlights of the

small vessels inside the harbor coming out, feeling along for the buoys, and at four o'clock that morning, after having been on a peace footing until eleven o'clock the same night, we started for the coast of Cuba, and at four o'clock that afternoon we locked Mr. Blanco up in proper shape in Havana. (Applause.) I believe it was a record-breaker in the way of establishing a blockade. I do not think there is anything in history that equals it, and, as to the effectiveness of the blockade, of course you all know about that. We starved a good many people to death, and, unfortunately, most of them were our friends. From the day the blockade was established, April 22, until the close of the Spanish war, with a hundred and eighteen ships in commission on that coast, without a light at night, there never was a single collision in that fleet, which shows you not only were your ships good, but your officers had been fairly trained to their business. We were in all sorts of close places frequently at night, with twenty ships so close together that you could hail from one to another, but at no time could we see one ship from the other, no lights in them, all lying in the dark; but we managed to keep clear of each other. None of our ships were sunk, notwithstanding the opinion entertained in the country and expressed through the newspapers, that when we got these terrible machines going, these awful steel ships with all their torpedoes and new machinery, that we would smash each other up instead of the enemy. We did not do anything of the sort — we smashed the enemy when we got the opportunity. (Applause.)

There is one thing that I would like to impress on all you smart North American business men who run the country — as you undoubtedly do, and run it very well — do not let us get back to the position we were in 1882. We had come out of a great war then, after a magnificent record in the Navy, but we soon dropped behind everybody else; we simply stopped in our tracks while other countries went ahead. We have just come out of a small affair in the way of a war; but do not let us stop now. Keep shoving us along; keep us up to our work; give us plenty of new ships. I do not know that you will require to use them; it is not my business to argue that part of the question; we do what our employers want us to do. If you want us to fight Spain, we will do it. If you want to hold the Philippine Islands — of course in the Navy we have nothing to say about that — but if you want them, give us the word, and I think we will hold them for you. (Applause.) Keep us up to our work, gentlemen.

Do not let us drop back and do not let us stop. There is a very large watermelon out in the East Indies. It may be cut; if it is, we want our slice. (Applause.) It may be that you will preserve that watermelon, but you know a watermelon patch is a very tempting thing to lots of people, and there are lots of varmints that like to get at the watermelons. If the trade of China is a watermelon sufficiently large for you to want your share of it, then I beg of you to keep us in condition to get you your share when you want it; but if you prefer to cut your watermelon now and take your slice of it, let us know and we will get it for you. (Applause.)

One thing remember, please, that in the Navy we must have a little time for preparation. You can not make officers and sailors in a week, and if the ladies will not mind a story just a little off color, of an incident that occurred during the late war, I will relate it to illustrate what I mean. I had on board the Iowa some very excellent men from Detroit, Michigan. (Applause.) These men came to me off Cienfuegos, on the south side of Cuba. There were thirty-six of them, I remember. They arrived at my ship about 2 o'clock in the afternoon, fine looking chaps, tall, big fellows, all anxious to do their duty. We did not have time to drill them, of course. It was pretty hot weather and we were watching the enemy, and we gave them their stations, their hammocks and their messes, and got them so they would be comfortable, and at 8 o'clock that evening there was an alarm of Spanish torpedo boats coming. Of course everything was fight in a minute. As I was passing from my cabin up through the superstructure of the Iowa, I felt some one catch me by the sleeve, as I went along, and a voice in my ear said, "I say, Mister." I was a little surprised at that. I looked around and I saw one of these big Detroit recruits, a fine-looking chap, and I said, "Well, what is it?" He said, "I came down here to fight, sir, and I want to fight, and I don't know where to go." (Laughter.) There was an electric stand light near the man, right by us, so I said, "Where are you stationed?" He put his hand in his pocket and pulled out the little slip of paper that had his station on it, and he read it off to me. He said, "I am stationed in the port after eight-inch turret." I said, "that is fortunate; that is right here," and I pointed it out to him. He said, "Yes, I know it is, but how the hell do you get into it?" (Laughter and applause.) I was not very much surprised at the recruit when I looked around; there was this steel turret; there were no holes in it; apparently there was no way to get into

it. That story I simply tell you as an illustration. Those fellows must know how to get into the turrets. They must know what to do after they get in, and they must do it well.

In the Battle of Santiago, July 3, nearly a year ago, the United States had an enlisted force in its ships that in my judgment has never been equaled in the world before. We were ninety-seven per cent Americans. (Applause.) We were eighty-five per cent native-born Americans. (Applause.) I say to you without hesitation, the greatest moment of my life, and I believe the greatest moment of any man's life — never could be anything finer — was that minute when the Spanish ships came out, when the first came in sight, to hear these North Americans cheer and see their faces get red, and see their eyes snap — 600 of them; every man of them wanted to fight, and every man of them knew how to fight, and every man of them that morning did fight hard and well. I say to you without hesitation that it would not have made a particle of difference if it had been six English battleships — I mean six German battleships (great applause and laughter) — it would not have made any difference whose battleships they were; they would have been whipped all the same. (Applause.) And I say that not without reason, because you have only to take the hits on the Spanish ships, and if we had hit any ships on the earth the same way we hit them we would have whipped them. It was simply the effect of shot and shell; it doesn't make any difference about the nationality. If they had been steel men in there they would have been whipped all the same. We would have sunk any other ships, beyond any question, if we had hit them the same number of times, and I do not believe anything could have stopped us from hitting them just that often. I am very much obliged to you. (Prolonged applause.)

Three cheers were given for Captain Evans.

THE PRESIDENT: Now, ladies and gentlemen, I think it would be proper for every one in the room to rise and give the Captain the Chautauqua salute, and then we will proceed with our business. The ladies can join in this.

The entire audience rose and joined in giving the salute, after which there was an intermission of several minutes in the proceedings while Captain Evans held an impromptu reception in a corner of the room.

THE PRESIDENT: The convention will come to order. The con-

vention is open for its regular business. The Secretary has some matters to bring before the convention which he will now present.

MR. CLOUD: As you were notified yesterday, there is a box near the door where members should deposit a card at least once during this convention if they want their presence here to be recorded.

THE PRESIDENT: Gentlemen, we will resume the reports of committees. We will take up the second report, which is "The best method of preventing trouble in boilers from water impurities." Mr. Manchester will please present the report.

Mr. Manchester presented the following report:

REPORT OF COMMITTEE ON THE BEST METHODS OF PREVENTING TROUBLE IN BOILERS FROM WATER IMPURITIES.

To the President and Members of the American Railway Master Mechanics' Association:

To the circular of inquiry forwarded by the committee to members of the Association, twenty-three replies have been received.

Question No. 1: "What are the troubles which occur in boilers from water impurities on your lines?"

Of those answering, six have no troubles.

A résumé of the replies, from those having impure water to contend with, shows the trouble to be the accumulation of mud or scale upon the parts forming the heating surface, preventing a free transmission of heat to the water, thereby reducing the evaporative efficiency of the fuel, clogging up the space around the fire box and between the flues, retarding the circulation. Bulging, cracking, furrowing, pitting and burning out of fire-box sheets, leaky stay bolts and flues, and water foaming in boiler.

Question No. 2:

"What have you done to overcome water impurities on your lines, and what have been the results? Please give the committee a statement of your method.

"Where appliances are used, send drawing and explanation.

"Where special methods and appliances have been used and abandoned, send drawings or explanations, and state why they were discontinued."

The answers develop the fact that, where water conditions demand it, a variety of methods for softening and purifying water is receiving earnest attention — by filtering, treatment in wayside tanks, by direct introduction of chemicals into the engine tender or boiler, and by mechanical devices, all of which have their advocates and, to a certain extent, are proving successful.

Of the chemical agents and boiler compounds that have been tried and are in use, we will mention a few of the best known: Lime, carbonate of soda in its various forms, tri-sodium phosphate, tannin, numerous patent compositions, boiler cleans-

ers and purges, several kinds of so-called boiler oils, mechanical boiler cleansers and feed-water heaters, in addition to the usual surface and blow-off cocks and washing out of boilers.

Question No. 3: "What is your cost per 1,000 miles of engine mileage for water purifiers?"

Eleven use no purifying method.

Two advise that their records do not give this information.

One	gives	cost at	$ .14.5	
"	"	"	.17.8	
"	"	"	.35	
"	"	"	.29	in passenger.
"	"	"	.37	in freight.
"	"	"	.43	in switching.
"	"	"	3.00	
"	"	"	3.50	

Question No. 4: "What is your cost per 1,000 miles of engine mileage for boiler washing?"

One	reports	cost as	$ .50	
"	"	"	.82	on different divisions.
"	"	"	1.00	
"	"	"	.75	with purified water.
"	"	"	1.97	with unpurified water.
"	"	"	.75	for labor.
			.20	for material.
"	"	"	.40	
"	"	"	.40	
"	"	"	1.30	including firing up.
"	"	"	.60.28	
"	"	"	.24	
"	"	"	.30	on different divisions.
"	"	"	.86	

Question No. 5: "Do you find the cost of boiler washing increased or decreased by the use of purifying agents? If so, to what extent?"

Those using purifying agents who replied to the circular, either say unchanged or decreased from one to two washouts per month. One road gives a saving of 60 per cent.

Question No. 6: "To what extent does boiler washing reduce the maximum mileage that might be made by your engines?"

From the information received in answer to this question, it seems there is practically no loss of mileage on this account. The majority state that boilers are washed while other necessary repairs are being made. A few have estimated losses on this account from 2 to 10 per cent.

Question No. 7: "Give the average mileage and life of flues and fire boxes in your engines."

The wide difference in the mileage and life of flues and fire boxes on roads in different sections of the country, as indicated by the figures given in answer to this question, emphasizes the necessity of water purification. One member gives 18,000 miles as the average mileage, and seven months as the life of the flues, and fifteen months to three years as the life of a fire box. Another reports 150,000 to 300,000 miles, and from three to eight years as the mileage and life of the flues. As for fire boxes — no record. Fire boxes thirteen years old show no signs of weakness.

Of those answering the circular who have adopted purifying methods, the majority use soda ash, introducing it direct to the tender or boiler, and dispose of the sludge by blowing and washing out. One member says: "Our difficulties have been much ameliorated by the introduction of soda ash. The most marked results have been with through passenger trains in Illinois. Formerly we could not run our flues with any degree of security more than 50,000 miles. Since the introduction of soda ash we get a mileage of 130,000 to 150,000 from flues without removing them; and by the introduction of pneumatic blow-off cocks the time between washouts has been increased."

The experience of the Chicago, Milwaukee & St. Paul Company with soda ash extends over a period of twelve years, during which time it has been regularly used on all divisions of the system, and for a number of years the results have been uniformly beneficial. But it was not until a thorough system of boiler washing was inaugurated and a competent man installed as boiler-washing inspector, whose duty it was to visit all roundhouses, inspect boilers and give instructions in blowing and washing out, that best results were obtained.

In the waters where carbonates and sulphates are present in such quantities that to add sufficient soda ash to precipitate the lime salts would give such a concentration of alkali in the boiler as to cause a constant foaming, it has not been possible to entirely neutralize the scale-making properties, but they have been so much improved that the life and mileage of flues and fire boxes have been more than doubled.

While the cost of boiler washing has been somewhat decreased as compared with the days before soda ash was used, the greatest saving has been in the better service and greater mileage of the engines, and the great reduction in boiler work, the boilermakers' pay roll showing a reduction of $75,000 per annum.

Boiler washing and blowing out being such an important factor when soda ash, as the reagent, is introduced into the tender, it may not be out of place to refer to what is considered good practice. There should be a sufficient number of blow-off cocks so distributed as to reach the centers of the greatest deposits of sediment. The principal blowing off should be done at the completion of the trip, and before the engine goes into the roundhouse. It should stand for a sufficient time for the mud to settle to within a few inches of the bottom of the boiler. In this way, with the loss of the least water, the greatest amount of sludge will be drawn off. In washing out, when the service will admit, it is beneficial to allow the boiler to cool down before letting out the water. When the time is short, this can be hastened by filling the boiler full and keeping it full by forcing water in as fast as it runs out until cooled down to the desired temperature.

In the proceedings of 1895, in the report of the Committee on the Causes of

Bulging of Fire-Box Sheets, is described what we consider the best practice in boiler washing.

For the benefit of this committee, and to determine to what extent the blow-off cocks should be depended upon to keep a boiler clean, some tests were made upon the Chicago, Milwaukee & St. Paul System.

A TEST WITH BLOW-OFF COCKS ON THE CHICAGO, MILWAUKEE & ST. PAUL RAILROAD.

The engine selected for this purpose was a compound, the general dimensions of which are shown in Fig. 1. It was built and did first service in January, 1896,

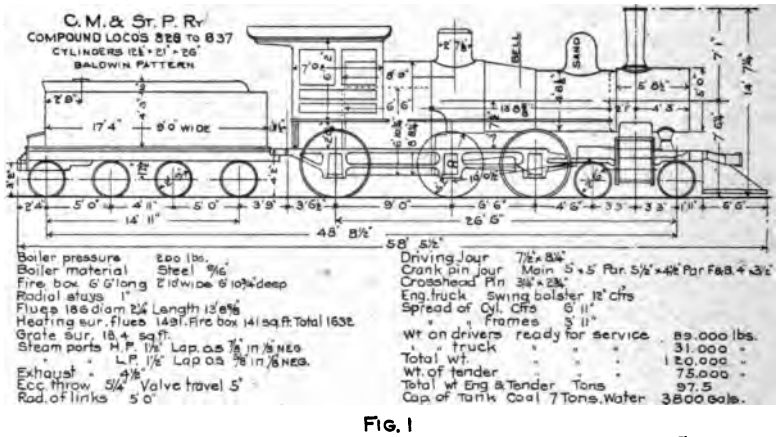

C. M. & St. P. Ry.
COMPOUND LOCOS 828 to 837
CYLINDERS 12½ × 21 × 26
BALDWIN PATTERN
17'4"
8'0" WIDE
BELL
SAND
14' 11"
26' 6"
48' 8½"
58' 5½"
Boiler pressure 200 lbs.
Boiler material Steel 9/16
Fire box 6' 6" long 2' 10" wide 6' 10¾" deep
Radial stays 1"
Flues 186 diam 2¼ Length 13' 6⅝
Heating sur. flues 1491. Fire box 141 sq ft. Total 1632.
Grate sur. 18.4 sq ft.
Steam ports H.P. 1⅞ Lap 0.85 ⅞ in ⅛ NEG.
" " L.P. 1⅞ Lap 0.85 ⅞ in ⅛ NEG.
Exhaust " 4½"
Ecc. throw 5¼" Valve travel 5"
Rod of links 5' 0"
Driving Jour 7½" × 8½"
Crank pin jour Main 5" × 5" Par. 5½" × 4½" Par F&B 4" × 3½"
Crosshead Pin 3½" × 2½"
Eng. truck Swing bolster 12" Cffs
Spread of Cyl. Cffs 6' 11"
" " Frames 5' 11"
Wt on drivers ready for service 89.000 lbs.
" " truck " " " 31.000 "
Total wt. " " " 120.000 "
Wt. of tender " " " 75.000 "
Total wt Eng & Tender Tons 97.5
Cap. of Tank Coal 7 Tons, Water 3800 Gals.

FIG. 1

and had, up to the time of starting the test, made 143,268 miles with the flues with which it left the builder's shop. This mileage was made on the La Crosse Division; the engine receiving the same treatment as to washing out and changing of water as all freight engines on that division, which was an average of 1,300 miles between washouts with water changed between. The water used was the same as shown in the table of water analysis for the La Crosse Division. (See page 23.)

The test was made to determine if with a sufficient number of blow-off cocks, and systematic blowing off, a boiler in heavy freight service on that division could be run for a longer time than was the practice, without fully changing the water or washing the boiler, and at the same time avoid leaky flues or water foaming. It was deemed advisable to make the test with an engine that had made large mileage since flues were changed, as a less disturbance would cause them to leak more quickly than if recently put in. The arrangement of blow-off cocks was as shown in Fig. 2. A water glass in boiler head, extending from the top of the boiler to deck plate (see Fig. 3) was used to watch the movements of the sludge. Fig. 4 shows a graduated water glass as applied to front end of tank, which was used to show the amount of water taken at each station, also to determine the amount blown

out each time. This was done by taking a reading of the height of the water in the tank and boiler, and after the desired amount had been blown out, and the boiler refilled to the original level, the glass in tank would show how much water was used in refilling. This was taken as the amount blown off. A competent man followed the engine — handling the blow-off cocks — keeping a record of the water taken and of the soda ash applied, and to watch the action of water through the water glass.

Upon arrival at Milwaukee each trip, a can of water was drawn from the gauge cock, and after the boiler was blown down and refilled, a second can was drawn in the same way, both being sent to the laboratory for analysis. At the opposite end of

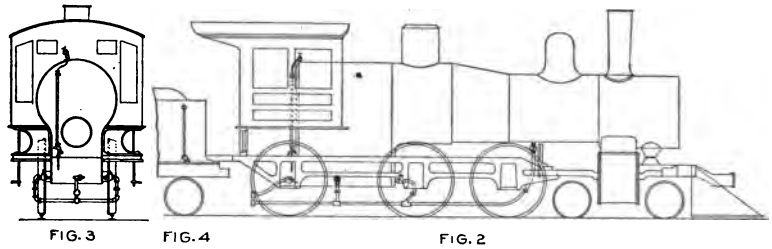


FIG. 3 FIG. 4 FIG. 2

C. M. & ST. P. RY.
MOTIVE POWER DEPT.
TEST ARRANGEMENT OF BLOW-OFF COCKS.
ENGINE No. 828.

the road, blowing off was done in the same way, but no water was drawn to be analyzed. After arriving at the terminal and before opening the blow-off cocks, the engine was allowed to stand until the water glass showed the water clear down to a point on a line with the bottom of cylinder part of boiler. The time required for this was found to be about twelve minutes. The blow-off cock in cylinder part of boiler was then opened for twenty seconds; both injectors were then put on full head, and the blow-off on left side and front of fire box opened for about forty seconds; then the cocks on right and back of fire box were opened for about the same time. The usual amount of water blown out was 500 gallons. The expectation was that this method would not only remove a part of the heavy mud which had settled to the bottom, but much of the lighter product, which, while the engine was in motion and generating steam rapidly, was diffused through the water; also, that the quantity of fresh water injected would dilute the alkali to a point that would cause no trouble by foaming with the added soda ash until the next blow-off point was reached.

The results of the tests given in Table No. 1 comprise thirteen trips in freight service; the first from Milwaukee to Portage and return — 200 miles, and twelve trips, Milwaukee to La Crosse and return, 400 miles per trip, making a total of 5,000 miles. During this time the boiler was not washed, or the water changed, except the amount blown out as shown in table. A careful examination of the interior of the boiler before starting and at the completion of the test, discovered no change

in its condition, and indicated that the treatment might have been continued indefinitely without detriment to the service or boiler. The mud and sludge washed out after running 5,000 miles was no greater than usually found in boilers washed at the usual interval.

The report of the engineers and men in charge during the test is that at no time was there any indication of the water raising or foaming. The only change of appearance of the water in the glass was when nearing the end of the trip. It would become more cloudy in the lower and central portion, showing the thickest in the lower end, and gradually shading to clear water at the top of the water line, with clear water showing at all times in the top twelve inches of the water glass.

In the table is given the train number and date for each trip, the stations and amount of water in gallons taken at each, the number of pounds of sludge and alkali in each amount of water taken, and the quantity of soda ash introduced into the tank, with a footing of the results for each trip and for each round trip. The difference in the two items, total water taken and used, the latter being the amount evaporated, is obtained by taking from the total the amount of water in boiler at starting, the quantity blown out, and the amount remaining in the tender at the completion of the round trip.

In the totals of all trips in the column, "Soda Ash Used," which was 149.3 pounds, and "Soda Ash Specified," 60.49 pounds, it might seem that something different than the regular practice was being done, but such was not the case. The number of pounds of soda ash put in the tender was the same as the prescribed quantity for all freight engines on the division, and the difference is accounted for by the small quantity of water used by this engine. The rule fixing the amount of soda ash to be used each trip was made for a simple engine on one of the hardest runs. To insure each engine receiving the necessary quantity for purifying the water used on the hardest trip, the maximum amount required was fixed as the regular quantity to be furnished; simple and compound engines receiving the same treatment.

This test was made with a compound engine, using considerably less water, and with the exception of one trip the trains handled were all through runs, having no way work or switching. This accounts for the difference in water used and the consequent greater amount of soda ash furnished than the amount and condition of the water required.

Mr. H. E. Smith, chemist at West Milwaukee, has supervision of the chemical laboratory, and all work of this character is under his direction. The analysis of the water and making up of the table was directed by him. His explanation of the table and rules and practices on the Chicago, Milwaukee & St. Paul Railway in water purification, together with his observations of the characters of waters to be treated, is made a part of this report.

NOTES ON THE CHEMICAL FEATURES OF WATER PURIFICATION.

BY H. E. SMITH, CHEMIST FOR C. M. & ST. P. R'Y.

The solids present in boiler waters may be divided into two classes, the incrusting and non-incrusting solids. In the majority of boiler waters of the United States the incrusting solids consist largely of calcium and magnesium carbonates, and calcium sulphates. Under the action of heat alone, the carbonates are precipitated at 212° Fahr. and the sulphate at about 260° Fahr. The sulphate is much more injurious than the carbonate, because it forms a much harder and denser incrustation. Occasionally magnesium sulphate or chloride is present. These two substances are soluble in water, but when heated under pressure, especially if in the presence of iron, are decomposed, magnesium hydroxide being precipitated as incrustation, while the acid is set free, as a corrosive element. Silica, alumina and oxide of iron are generally present in small amounts and enter the incrustation.

The non-incrusting solids are the compounds of the alkalies, and are usually made up of sodium and potassium sulphates, and sodium chloride. Sodium carbonate and potassium chloride are sometimes present. None of these compounds form incrustations, but, on the other hand, cause foaming if present in large amounts. Our experiments indicate that, other things being equal, the various alkali compounds are about equally efficient in producing foaming.

In actual practice, however, the carbonates produce a flocculent sludge with waters containing calcium and magnesium compounds, and on this account are indirectly more efficient than sulphates or chlorides in producing foaming.

Occasionally free mineral acid, generally sulphuric acid, is found in natural waters, and produces corrosion. Sewage, and some kinds of factory waste, produce both foaming and corrosion. Suspended solids obviously produce incrustation, and sometimes foaming. When waters are treated in the boiler with soda ash, the incrusting solids are changed to carbonates and precipitated as a soft sludge which is readily blown out, instead of coming down in crystalline condition and adhering to the surface of the boiler. Extended experience has shown that it is not necessary to use as large an amount of soda ash as the full chemical equivalent of the incrusting solids. This is of very decided advantage in boiler operation. There appear to be several reasons for this fact, as follows:

1. If no precipitant is used, all of the nominally incrusting solids do not immediately adhere to the boiler, but may be easily removed by blowing or washing.

2. When soda ash acts upon calcium and magnesium sulphates it is changed to sodium sulphate, which has no further action as a precipitant. But calcium and magnesium carbonates require for their precipitation only the absorption of the free carbonic acid gas of the water. This action leaves the soda ash in the form of bicarbonate, which, by the heat of the boiler, is gradually changed back to the normal carbonate (soda ash), which can then act upon a fresh portion of incrusting solids.

3. The flocculent sludge produced by the direct action of the soda ash doubtless incloses particles of crystalline solids which are thrown down by heat alone, thereby preventing them from adhering to the boiler.

In calculating the amount of soda ash to be used, we employ the following table of ratios, which represents present average practice:

One grain of the following salts per gallon of feed water.	Requires per 1,000 gallons of feed water, the following amounts of 58° soda ash.
Calcium or magnesium carbonate	0.02 pound.
Calcium sulphate	0.10 "
Magnesium sulphate	0.13 "
Magnesium chloride	0.16 "

The proper ratios to be employed vary somewhat according to the amount and character of the incrusting solids and the amounts of alkalies in the waters. They also vary according to the service of boilers and the care used in blowing and washing out. The ratios given are suitable for the average waters of the Mississippi Valley, for boilers which receive reasonably good care. The proportion of the soda ash specified for carbonates is only about one-seventh of the chemical equivalent. That for calcium sulphate is nearly the full equivalent, while for magnesium sulphate and chloride the theoretical amount is used on account of the corrosive nature of the salts. Some waters contain originally some sodium carbonate, in which case less soda ash is needed, or it may be entirely dispensed with. This is the case with the Portage and Kilbourn City waters used in the tests.

On account of foaming, it is not desirable to use more than 10 pounds of soda ash per 100 miles, even if the calculation calls for more.

Referring now to the tests on the La Crosse Division, Table No. 2 gives the composition of the waters used. The waters at Milwaukee, and from Portage to La Crosse, inclusive, are classed as good, the incrusting solids being low and practically all in the form of carbonates, and the alkalies being low. The waters from Brookfield to Columbus, inclusive, are classed as fair. The column headed " Sludge Formed " shows the weights of sludge which will form in the boiler if the waters are used with soda ash treatment. It is assumed that all calcium compounds are precipitated as carbonates and magnesium compounds as basic carbonates. It should be remarked that the greater the proportion of soda ash used the more flocculent is the sludge and the greater its tendency to cause foaming. The physical properties of the sludge are therefore very important.

Table No. 1 shows, for each trip, the amount of each water taken, with the amounts of sludge formed and alkali contained, also the amounts of soda ash used per trip. The amount of sludge formed per round trip varied from 23 to 35 pounds. It was not practical to determine the amount of sludge blown out, so that the amount present in the boiler cannot be definitely stated. At the bottom of the table are shown the amounts of alkali actually present in the boiler at the end of each round trip, as shown by analysis of a sample of the water drawn from the lower gauge cock. The " alkali carbonate " represents soda ash which has not been changed to sulphate by reaction with the calcium sulphate of the water; " other alkali " consists chiefly of sulphate due to the reaction just mentioned, and also that originally present. It also includes small amounts of nitrates and chlorides originally present. In no case did more than slight traces of incrusting solids remain in the water.

The amount of total alkali rises to 90 grains per gallon at the end of the second trip and remains in the neighborhood of 100 grains for the greater part of the test.

On the last three trips the alkali falls off, more water having been blown out than on previous trips. It will be noticed that the proportion of unchanged soda ash gradually increases from less than one-third to over one-half. It is elsewhere explained that the allowance of soda ash was in excess of the requirements for the particular trains and engine used. It is not to be inferred, however, that the water in the boiler should show no unchanged ash. A certain amount is required to insure that calcium and magnesium carbonates originally present in the water shall be thrown down in sufficiently flocculent condition.

In the calculations, the amount of alkali found in the water after blowing out and filling the boiler at the end of the trip is carried forward to the next trip. These figures are probably considerably in error. Of necessity, the "after filling" sample was drawn before the engine had done any work or the water in the boiler become thoroughly mixed, and it therefore contains less than its proper proportion of fresh water. This is further substantiated by the fact that the reduction in alkalies indicated by the analysis is much less than would correspond to the amount of water blown out of the boiler.

The average amount of water blown out is 4.2 per cent of that taken. This is not more than may be wasted with the sludge in way-side settling or filtration plants which leave five to ten grains per gallon of incrusting solids in the purified water. In the boiler treatment, the wasted water is hot, however.

It is elsewhere stated that during the test the boiler carried water perfectly and made no incrustation. In view of the various facts above narrated, it is believed that both the amount of soda ash added and the amount of water blown out could be materially reduced. There is no doubt that the greater proportion of the sludge is removed during the first few seconds that the blow-off cock is open.

A second series of tests were made to determine the amount of alkali which a locomotive boiler could carry when there were no sludge conditions to assist in causing foaming.

The test was made with a C. M. & St. P. engine in heavy freight transfer service between their Muskego and Chestnut Street Yards in Milwaukee. The length of the run from Muskego to Chestnut Street Yard is thirteen miles, and the condition of the service such that during a considerable portion of the distance as high a rate of speed as it was possible to attain with the train, could be made. The results of the test were:

TEST TO DETERMINE THE MAXIMUM AMOUNT OF ALKALI WHICH A LOCOMOTIVE BOILER CAN CARRY.

These tests were made with an engine doing heavy transfer service near Milwaukee, and running over three heavy grades. Lake Michigan water was used exclusively, it being desired to have present in the boiler as little sludge as possible. The boiler was washed out every night, an entirely fresh test being conducted each day. For the same purpose of avoiding sludge in the boiler, the alkali was added during the morning trip as far as possible, a solution of soda ash being run directly into the boiler by means of a branch pipe on the injector. The amount and final form of the alkali is indicated by the appended analysis (Table No. 3).

First Day.— Ten pounds of soda ash were placed in the boiler at time of washing, and further quantities, in solution, were added at short intervals on starting

out with the train. Going up the first hill the boiler began to foam and engine stalled on that account. There was no opportunity to take a sample at this point, but from the amounts of solution added it is estimated that there was present in the boiler ninety-five per cent of the alkali indicated by Sample No. 1.

A small further addition of solution was made during the remainder of the trip and before Sample No. 1 was taken. On the return trip another small addition of alkali was made and more or less foaming took place, but the engine did not stall. At the end of this trip, Sample No. 2 was taken, which shows that the addition of alkali (about 15 grains per gallon) made during the return trip, just about balanced the loss by foaming. No more alkali was added during the day.

On the second return trip (in the afternoon) the boiler foamed very badly. When the engine was shut off no water showed in the glass, although both injectors were working. This foaming was attributed to some mud in the tender, which was stirred up by filling through a long hose which reached to the bottom of tender. On the third trip no difficulty was experienced. Sample No. 3 shows the condition of the water at the close of this, the last trip for the day. The loss of alkali is probably that due to foaming.

Second Day.— In this test the alkali was added more slowly. On the first round trip no foaming took place and at the end of the trip the sample (No. 4) showed 147 grains total alkali.

On the second north-bound trip the boiler began to foam on the second grade, but did not delay the train. Sample No. 5 shows the condition of the water, the concentration being 160 grains. Foaming continued throughout the round trip, the boiler carrying as much alkali as was allowable without causing delay.

On the third trip the conditions were similar. Analysis No. 6 gives the composition of the water at the end of the trip. It will be noticed that considerable alkali had worked out of the boiler, but there was a greater accumulation of sludge.

Third Day.— In this test the soda ash was added quite rapidly on the start. Sample No. 7 shows the composition of the water at the close of the first north-bound trip, the engine raising water badly.

Sample No. 8 was taken while climbing a heavy grade in the first part of the return trip, the boiler foaming badly.

Sample No. 9 was taken during the second north-bound trip, the conditions being unchanged. The loss of alkali caused by the foaming is shown by the analysis to be exactly balanced by the small additions of soda ash, which were made from time to time. The test was closed at the end of the second round trip (Sample No. 10), the conditions remaining unchanged.

The general result of the test shows that if water in a hard-worked boiler is fairly free from sludge, the alkali must not rise above 160 to 170 grains per gallon, and for satisfactory work, should not rise above 140 grains. It is also shown that considerable amounts of alkali are carried out with the water lost from a foaming boiler, so that at the end of several hours' working the alkali present in the boiler is less than the total added.

TABLE No. 3.

ANALYSIS OF WATER FROM BOILER OF ENGINE No. 91, IN FREIGHT TRANSFER SERVICE BETWEEN MUSKEGO YARD AND CHESTNUT STREET.

Sample No.	Sodium Carbonate.	Other Alkali.	Total Alkali.
1	126.70	40.96	167.66
2	126.70	39.51	166.21
3	97.08	50.41	147.49
4	130.98	15.99	146.97
5	143.80	15.82	159.62
6	106.85	22.73	129.58
7	131.89	47.03	178.92
8	127.24	50.62	177.86
9	130.91	48.88	179.79
10	117.48	49.19	166.67

TREATMENT OF WATER AT PUMPING STATIONS.

Water purification at the pumping station where scale-making matter is present in large quantities is the method advocated by several members of the Association. They assert that no two waters, from different natural sources, are just alike, and the treatment should be varied to suit each particular case, which can only be done by the pumping-plant treatment.

This method is by no means a new proposition. Lime, or combined lime and soda, have been used for more than fifty years, and is known as the Clarke or Clarke-Porter method of purification. Later, other reagents have entered the field.

The experience of the Union Pacific Railway with tri-sodium phosphates will, we believe, be of interest to the convention. Their report says: "On Nebraska Division, between North Platte and Sydney, the water has a trace of sulphuric acid, which is very destructive to the flues and fire boxes. Before the use of tri-sodium phosphates the average mileage of flues was 30,000 in freight service and 35,000 in passenger; fire boxes, 30 months in freight and 36 months in passenger service.

"Our experiment was first made with two engines in the same condition. One was treated with tri-sodium compound—the other was not. The engine treated with compound cost $2.01 for boiler washing, against $15.41 on the other. The cost for boiler work on the engine using boiler compound was $2.81, against $22.09 for work on engine not using the compound. The results obtained on these two engines led to continuing the test six months.

"In place of depositing the compound in the locomotive tank, we arranged to pump the necessary amount into the station tanks for each one thousand gallons of water used. By this means all engines running on the division received the treated water. An agent of the company furnishing the compound remains in the district, instructing the pumpers and seeing that the necessary amount of compound is put into the tank.

The test began September 12, 1898. A result of the six months' test as compared with the six months of previous year is shown in Table No. 4:

Year.	Engine Mileage.	Tri-sodium Phosphate Used.		Boilers Washed.		Boilers Blown Out.		Boiler Work Reported.	
		Pounds.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.
1897–8	362.756	.....	.....	1,241	$786.75	.....	.....	1,120	$2,073.85
1898–9	517,007	2,937	$1,791.56	421	330.78	1,017	$118.78	493	1,083.99

Cost of boiler work and washing in 1897-8 (no T. S. P. used)..... $2,860.60
Cost of boiler work and washing in 1898-9 (using T. S. P.)..... 1,533.55

Decreased $1,327.05
Cost of tri-soda phosphate water purifier in 1898-9 .... 1,791.56

Increase in expense in 1898-9 compared with 1897-8 (35 per cent)..... $464.51

Increase in engine mileage for same periods, $42\frac{5}{10}$ per cent.

Year.	Engine Mileage.	Cost per 1,000 Miles.			
		Washing and Blowing Out.	Boiler Work.	T. S. P.	Total.
1897–8...	362,756	$2.16	$5.72	.....	$7.88
1898–9...	517,007	.87	2.09	$3.47	6.43
Decrease per 1,000 miles.		1.29	3.63	.....	1.45
Percentage of Decrease.		60%	63½%	.....	$18\frac{4}{10}$%

Net saving per 1,000 miles..... $1.45
" " for six months 749.65

Cost of water purification with tri-sodium phosphate, 4½ cents per 1,000 gallons.

Representing an actual saving on third district of $1,500 per annum.

The first effect derived from the water purifier was the tightening of leaky flues and fire boxes of engines using it, and a consequent reduction in boiler work on those engines. Where boilers had been washed every other trip, and water changed the intermediate trip, they are now run from six to eight trips regularly to one washing, and one engine was run thirty days (4,860 miles) to one washing, by simply blowing out three gauges of water at the end of each trip. From September 15 to October 31, every available engine was pressed into service, and they were returned at terminals as soon as they could be made ready. During this period at least three more engines would have been necessary in the third district to have handled the business as promptly as it was handled had we not used the water purifier.

The benefit of water purifier to flues has already been noticeable, whereas the average mileage between the changing of flues of Third District engines has been 28,100 miles. Engine 647 made 38,122 miles, and, when taken into shop, both flues and crown sheet were unusually free from scale. Engine 1813 made 47,538

miles, and when overhauled, January 13, 1899, the flues were found in such good condition that only a few (39) were removed — in the belly of the boiler — to facilitate inspection. This is the first time in over eight years that a Third District engine has been shopped for repairs on account of worn-out condition and not necessary to change all of the flues.

Our chemist analyzed the sediment obtained from a boiler in which water purifier had been used, and reports that the action of the compound (water purifier) precipitates the phosphates of lime and magnesia, and prevents the carbonates and sulphates from adhering to the boiler, and, so far as he can judge, from the form of the composition of the scale, the chemical seems very efficient.

The water in the Third District is exceptionally bad for locomotive boilers. It has been necessary to renew fire boxes in engines in that district in two years, and three years is a fair average of the life of a box in engines permanently located there. It is fair to presume, therefore, considering the reduction of boiler work on Third District engines, that we may expect the life of fire boxes and flues to be extended correspondingly.

Table No. 5 gives the analysis of water treated:

ANALYSIS OF WATER.

	Silica.	Carb. Lime.	Carb. Magn.	Sul. Lime.	Sul. Magn.	Chlor. Soda.	Sul. Soda.	Ox. Iron.	Total Solid.
	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.
No. Platte	5.52	6.03	2.14	2.25	0.53	2.06	5.28	....	23.81
Hershey	1.17	8.10	....	7.68	4.54	2.80	1.68	....	26.90
Paxton	1.42	6.91	0.88	21.78	7.97	5.00	8.88	....	52.84
Ogallala	1.68	10.19	1.16	4.14	2.91	1.81	12.59	....	34.48
Big Springs	1.86	4.68	1.05	.09	.07	1.35	2.93	....	12.03
Julesburg	2.28	8.56	2.14	....	....	1.49	6.51	....	20.98
Chappell	1.48	8.10	2.28	1.12	....	1.18	4.90	....	19.06
Lodge Pole	1.17	10.09	2.43	....	....	1.42	10.90	....	26.01
Sidney	2.82	8.41	2.57	5.21	2.32	3.70	....	0.35	25.38

Grains organic matter, .92 Hershey.

STATION TREATMENT OF WATER BY N. Y. C. & ST. L. R. R.

Two water stations — Arcadia and Townsend — on the N. Y. C. & St. L. Railroad are now being treated by the combined lime and soda treatments.

The chemicals are handled by the man who does the pumping, and it is estimated the additional work costs the company nothing, as the man would have to be paid whether the water was treated or not. The lime-and-soda ash are made in solution by the pumper, and is fed gradually as the water is pumped into the auxiliary tank, a prescribed amount to 1,000 gallons; after being allowed from 12 to 20 hours to settle, it is pumped into the service tank, from which it is delivered to the engines.

To treat the water at Arcadia, soda ash and lime water are used; 55 gallons of saturated lime water and 3 pounds of soda ash to 1,000 gallons of water.

At Townsend, 80 gallons of saturated lime water and 2 pounds of soda ash per 1,000 gallons of water are used.

Table No. 6 gives an analysis of the water treated:

GRAINS PER U. S. GALLON.

	Total Solids.	Lime as Sulphates.	Alkali, Aluminum and Iron.	Magnesia.
Arcadia	106.40	23.38	0.29	5.04
Townsend	35.39	5.03	0.52	1.99

The cost at Arcadia for reagents is 3½ cents per 1,000 gallons; at Townsend, 2½ cents.

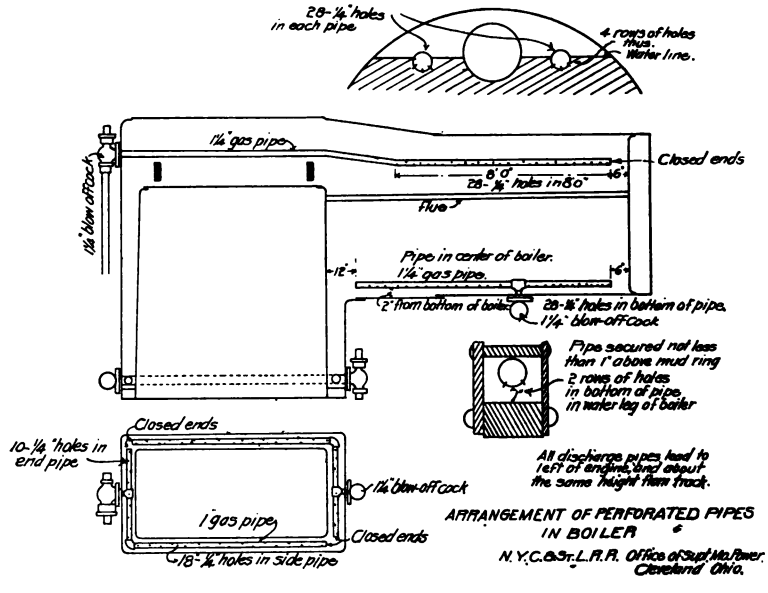

28-¼" holes in each pipe
4 rows of holes thus. Water line.
1¼" gas pipe
1¼" blow off cock
Closed ends
8' of 28-¼" holes in 8'0"
46"
Flue
12"
Pipe in center of boiler. 1¼" gas pipe.
6"
2" from bottom of boiler
28-¼" holes in bottom of pipe.
1¼" blow-off Cock
Pipe secured not less than 1" above mud ring
2 rows of holes in bottom of pipe in water leg of boiler
Closed ends
10-¼" holes in end pipe
1¼" blow-off cock
1" gas pipe
Closed ends
18-¼" holes in side pipe
All discharge pipes lead to left of engine, and about the same height from track.
ARRANGEMENT OF PERFORATED PIPES IN BOILER
N.Y.C. & St. L. R.R. Office of Supt. Motive Power. Cleveland Ohio.

FIG. 5

The auxiliary tanks have to be cleaned frequently to relieve them of the impurities.

The water at Arcadia, before treatment, was of such a nature as to give constant annoyance with leaky flues and fire boxes. It is now satisfactory. The alkali left in the water causes no trouble that cannot be entirely taken care of with the surface and blow-off cocks.

Figure No. 5 shows the arrangement of surface and blow-off cocks as used on their engines.

In Volume 19 of the Transactions of the American Society of Mechanical Engineers, is a paper by Mr. Howard Stillman describing a water plant at Port Los Angeles, Cal. Lime and soda ash are the reagents used. The purifying appliances have been carefully worked out in detail, and great care taken to insure a thorough

mixing and uniform delivery of the chemicals with the water, and easy methods of disposing of the sludge.

Since the writing of the above-named article, the practice has been extended on the Southern Pacific Railway.

In answering to the circular from the committee, Mr. Stillman says in part:

STATION TREATMENT OF WATER BY THE SOUTHERN PACIFIC RAILROAD.

We have introduced and have in operation at present, four plants for treatment of hard scaling waters. By introducing quicklime and soda ash in such proportion as required in water to neutralize carbonic acid and convert incrusting sulphates, allowing the precipitates to settle in ample tankage and drawing settled water from surface of tank, the method prevents corrosion, we find, and eliminates about 80 per cent of the scale salts. Fig. 6 shows the plant at Santa Paula, Cal. As shown, it was designed to be entirely automatic, but we found best to operate it for a required period at one time during the day, so as to allow more time for settlings. The float valve shown in Fig. 6 is therefore not in use, and the water is cut out at a valve in the main, just before entering the motor shown in plan. This motor consists simply of a horizontal water wheel enclosed in casting with cover about as heavy as locomotive cylinder heads. The wheel has ample clearance within its case and is driven from a nozzle at entrance of water main to water casing. The shaft of water wheel projects through a stuffing box and carries two small wheels. One of these wheels is a gear, engaging in a larger gear driving a regulating valve for the purpose of controlling chemical feed from the upright chemical tank, on lower floor; the flow from the chemical tank, through the regulating valve, is controlled by air pressure to suit the conditions under which the apparatus works, and gauged to be proportioned to the average hourly rate of flow through water main.

The second wheel on the motor shaft is a sprocket, and drives a central shaft and paddles within the upright chemical tank. When in operation, this paddle churns up the chemical mixtures, while feeding out.

The chemical solution, after passing the regulating valve, flows on through a ¾-inch pipe which taps into the water main at a point just before entering the large or circulating tank on the ground plane. This upright tank contains alternate baffle plates, to effect mixture of the chemical solution with the water in its upward flow through the circulating tank.

The water discharges into the service tank about four feet from the bottom through a horizontal nipple, giving a slowly rotating motion to the treated water. A wired 6-inch hose connects with the tank valve, the upper end of the hose being attached to a float, and by this means, the upper (open) end of the hose draws water about a foot from the surface, rising and falling with the level. The discharge from the gravity supply at Santa Paula is at a constant rate of 6,200 gallons per hour, and the amount of water used per day is about 24,000 gallons.

Precipitated matter in the service tank is removed by the spider-drain system of tank bottom outlets, discharging at the 9-inch mud valve, shown just between the chemical house and tank foundation on ground level. The water still contains about one-fifth the incrusting matter, but some falls in the boiler as sludge, and does not stick to boiler inside.

The plant at San Luis Obispo is similar in principle to the one described, but circumstances are somewhat different, and the water is also of a different character.

There are engines at San Luis Obispo using the treated water almost entirely, and it is now possible to let them go with boiler washing once a week, where formerly they were washed every night. Hard scale does not form with washing once a week, where formerly the washing daily did not remove the hard scale. It should be understood that the treating plants referred to are each on a different division of the road, and waters are poor on either side of points at which the plants are established. It is, therefore, difficult to state a figure for locomotive service that is reliable as to amount saved for boiler washing, etc.

The cost of water treatment at treatment plants is:

Santa Monica	4.00	cents	per	1,000	gallons.
Santa Paula	2.25	"	"	"	"
San Luis Obispo	2.30	"	"	"	"
El Paso	2.50	"	"	"	"

The analysis of the water from the Santa Paula plant before and after treatment shows it to contain:

	Treated.	Untreated.
Carbonate lime	1.98	10.85
Sulphate lime	Trace	4.36
Carbonate magnesium	2.68	1.05
Sulphate magnesium	.70	7.00
Silica	.41	1.05
Alkali carbonates	1.28	....
Alkali sulphate	20.53	8.51
Alkali chlorides	4.20	4.20
Total matter	31.78	36.92
Total incrusting	5.67	24.21
Total non-incrustings	26.11	12.71

Reagents for treating 1,000 gallons — lime, ¼ pound; soda ash 1¼ pound.

DIRECTIONS FOR CARE AND MANAGEMENT OF WATER-TREATING PLANTS AT SANTA PAULA AND SAN LUIS OBISPO.

The treatment is effected by injecting into the water main, by air pressure through the feed regulator attached to motor shaft, a chemical mixture from the upright chemical tank on lower floor.

This chemical tank is filled, as the mixture is required, from the mixing vat on upper floor.

The open vat contains the stated amount of chemicals with water for 10 inches depth of liquid when mixed and ready for use.

DIRECTIONS FOR MIXING CHEMICALS IN THE OPEN VATS.

Weigh out the required amount of lime and place in the vat, covering with water. Allow to stand about half an hour, by which time the lime should be thoroughly slacked. Now put in water until nearly the required 12-inch depth and stir thoroughly, adding the soda ash by sprinkling into the mixture from end of a shovel and continued stirring with the hoe to dissolve the soda.

NOTE.— If the soda ash is dumped into the vat in a mass, it will form the equivalent of sal soda and not dissolve easily.

Now fill the vat to the 12-inch depth with more water and additional stirring.

The above mixture may be made up in one-half or other proportional quantities and kept on tap as required for the upright chemical tank on lower floor. Care should be taken to stir up the solution while being run off from the vat.

Any accumulation of sand or rock remaining in the vat when drained, should be shoveled out and thrown away.

When held in the open vat, the chemical mixture will keep its full strength for a week or more.

When run off into chemical tank with all cocks closed the mixture will keep indefinitely.

All chemicals should be kept dry before use.

CARE OF SETTLING TANKS.

No rule can be established for the disposal of sludge. The valve outlet to spider-drain attachment to tank will require attention about once a month, probably, and should be opened at a time (as near as possible) longest since the treating plant has been in operation.

The valve should be wide open only long enough to draw off the heavy sludge.

MECHANICAL FEED-WATER PURIFIER.

Mechanical feed-water purifiers and heaters are receiving a share of attention as water purifying agents, and in some kinds of water are reasonably effective.

One of the most pronounced examples is furnished by the Union Pacific Railway. Their answer to the committee's circular says:

On the Wyoming Division, between Rawlins and Green River, we have had good success for the past five years with the Rushford Feed-Water Heater, where we found it necessary, owing to the large quantities of salt, soda, lime and magnesia, to wash boilers at the end of each trip of 133 miles. By the application of the feed-water heater we were enabled to run our engines two weeks without washing the boilers. The boilers are partly blown out by the hostler at each end of the run. This applies to passenger engines. On freight engines we sometimes blow some water out when half-way over the division. The purifier is so arranged that blowing off is done from cylinder part of the boiler and from front end and each side of leg of fire box. In the district where the heater has done such good work, the character of the water is strongly soda. At one tank (Red Desert) the water contains 90 grains of solid matter to the gallon, 82 of which are sulphate chloride and carbonate of soda. Bitter Creek, with 81 grains of solid matter, 79 are sulphate chloride and carbonate of soda. Wamsetter, with 52 grains of solids, 50 are soda. Fillmore, with 54 grains of solids, 50 are soda.

The mechanical purifier is well adapted for coping with the cases just cited. The blow-off cock is the only effective remedy for the more soluble alkalies. The active principle of all mechanical feed-water purifiers is the blow-off cock, and a good mechanical purifier is one with blow-off cocks sufficient in number and so located and connected to sediment-gathering devices as to reach all the mud-depositing points in the boiler, and without introducing inside of boiler obstructions which

may interfere with good boiler washing or with the free circulation of water and steam.

CLARIFICATION BY FILTERING AND SETTLING.

Filtering is the oldest artificial method of clarifying water, and removes the suspended impurities more completely than any other.

There are three kinds — the sand, block and cloth filters.

From the replies to the circular, but one refers to this method. The member says: "We have been trying sand filters, but the final results are not yet determined."

With railroads, the largest users of boiler feed waters, and their field of operation comprising the entire country, they must, of necessity, have to deal with every class of water known. It is but reasonable to assume that some of the waters used by them might be best treated by filtering.

Water from running streams, when free from visible impurities, is usually desirable for boiler use, but when polluted with earthy matter to an extent frequently seen, becomes troublesome and in some cases even dangerous. Excessive turbidity in boiler feed water always produces foaming and necessitates changing of water, and in some waters, where a considerable portion of the suspended matter is clay, if mixed with the ordinary boiler precipitations, a hard scale is found, resembling Portland cement.

In waters where the visible impurities have sufficient specific gravity to settle when freed from influence of currents or agitation, settling tanks, towers and reservoirs are effective, these methods may be further reinforced and a wider range of turbid waters clarified, including those in which the suspended impurities are more finely divided and buoyant, by treatment with sulphate of alumina and soda. The cleansing process may be hastened in proportion to the amount of chemical employed. Care should be taken that the alkali be in excess, otherwise the clarified water may be acid and corrosive.

Numerous city waterworks and manufacturing plants have proven the ability of the filter for clarifying turbid water, yet railroads are slow in taking advantage of these demonstrations. The only explanation seems to be indifference or neglect. Motive power officials otherwise alert as to the quality of all materials furnished the department have accepted poor water for use in boilers with a mild protest, or none at all. The department upon which devolved the responsibility of furnishing the supply figured only from the standpoint of first cost for plant, quantity, and how cheap per 1,000 gallons it may be delivered to the engines.

We believe an evolution is taking place along these lines, and in the near future good boiler waters will be considered cheap at any reasonable cost. The Missouri River and some of its tributaries are fairly good boiler waters when freed from suspended impurities. The visible matter is light and slow to settle. It quickly clogs the filter and makes frequent cleaning necessary. But the mechanical filter is built with the idea of making this work as light as possible. By the arrangement of a few valves, the flow of water through the filter is reversed and agitators put in motion, which, if the statements of manufacturers are to be relied upon, quickly removes the deposit with a loss of not to exceed 5 per cent of the water purified. Waters of this character should be freed from earthly impurities before being used in boilers.

PURIFICATION BY DISTILLATION.

The subject of water purification should not be passed without reference to the only method by which pure water may be obtained, that is, distillation, but when reviewed from a railroad standpoint, the cost is so out of proportion with what has been considered a fair price for water that only under the most aggravated poor-water conditions could this method be considered at all.

As regards the purification of water by evaporation, the evaporating plant of the Perim Coal Company in Red Sea may be taken as representing the most efficient practice of the day, and, if the efficiency thus obtained be taken as a basis, the commercial possibilities of this kind of water purification may be illustrated as follows:

The capacity of this plant is 61.8 gross tons of distilled water per twenty-four hours, or 138,142 pounds or 16,600 gallons. The amount of distilled water per pound of coal consumed was 35.7 pounds; therefore, the fuel consumption per 24 hours was 3,880 pounds. This is equivalent to 234 pounds of coal per 1,000 gallons of water.

Now take the case of a railroad water station of moderate capacity, large enough to supply 24 engines per day of 24 hours, or 100,000 gallons daily capacity.

The coal consumption will be 23,400 pounds per 24 hours, or 975 pounds per hour. Allowing 3 pounds of coal per horse-power per hour, the necessary boilers will develop 325 horse-power. The labor required to operate the plant would be about three men by day and two at night. At $2 each per day, the daily labor would amount to $10. Assuming coal to cost $2.50 per gross ton, the daily coal bill would be $26. Neglecting incidental expenses, maintenance, interest, etc., the daily operating expense is $36, or 36 cents per 1,000 gallons.

More clearly to illustrate the relative importance of these figures, the case may be assumed of a road operating 500 locomotives with an average mileage of 30,000 per locomotive per year. If the engines run on the average 30 miles per ton of coal, the annual coal consumption per locomotive will be 1,000 tons. Assuming 6 pounds of water to be evaporated per pound of coal, each locomotive would require annually 6,000 tons of water, or 1,608,000 gallons. At 36 cents per 1,000 gallons, the cost of water purification would be $580 per locomotive, and for 500 locomotives, $290,000, while the fuel burned by locomotives would cost $1,250,000. The increase in the fuel bill would be 23 per cent, leaving entirely out of consideration the very large increase in coal account. It is scarcely conceivable that the saving in fuel burned by locomotives, due to pure water, and the reduction in boiler repairs, could, under any circumstances, reach so large an amount.

SOME OF THE OBJECTIONS TO WATER TREATMENT METHODS.

In the paper thus far the successful efforts of members and others in preventing trouble in boilers from water impurities have been considered. The replies to the committee's circular were not all of this character. With several the results in this direction were not favorable. In some cases, the same methods from which one member derived benefit another finds trouble.

The soda ash treatment in the tender received a fair share of criticism, several stating that they had tried it with results not favorable, or that the trouble it made was greater than the benefits derived. In one case the member said it increased

boiler washing, made the boiler leak and prevented the engine from doing good work on the road.

The experience on the Southern Pacific Railroad with soda ash, as explained by Mr. Stillman, is given in full. He says:

"For almost a year we have tried the system of introducing soda ash into locomotive tenders (as an experiment) to neutralize the hardness of waters on Tucson Division; also Santa Barbara Branch, but have almost given up the practice, owing to the excessive foaming produced in the boilers. We found the soda had some effect in less quantity of scale deposit found, but the foaming so interfered with service that the system is about abandoned. It should be stated that many of the waters of the Arizona and New Mexico regions contain naturally a large quantity of soluble alkali matter, and the addition of soda ash only makes matters worse.

Another circumstance that affected the result was the fact that some of the waters contain an excessive amount naturally of carbonate of soda. Such waters do not contain much scaling matter, and always tend to produce foaming when mixed with a hard water. This we have found by bitter experience, and most of our troubles in the desert regions have been from this cause. These alkali carbonate waters are the most corrosive we have and produce pitting more than any other. Alkali carbonate is the same chemical as the soda ash used for purifying, and the reason for the corrosion of the neutral water referred to is the fact that the carbonate of soda occurs in well water as bicarbonate, which, by its unstable nature, lends its carbonic acid, in part, to attack iron plates. However these chemical principles may be, we had to almost abandon the use of soda ash owing to excessive foaming produced."

RECOMMENDATIONS OF THE COMMITTEE.

The first effort in preventing trouble in boilers from water impurities should be in searching out sources of supply furnishing the best obtainable feed waters.

1. In building a water station where, by a larger first outlay, water of a better quality (that is, costing less for purification) may be obtained, the question should be carefully considered before accepting the poorer water in order to save on first cost of plant. The treatment of water is expensive, and the cost will pay the interest on a large investment. For example, in a station furnishing 100,000 gallons of water in twenty-four hours, which costs 4½ cents per 1,000 gallons for purification, were it possible to substitute a supply costing but 2¼ cents per 1,000 gallons for treatment, an outlay of $16,425 would be warranted in order to bring about the change. The annual cost for purifying the 4½-cent water would be $1,642.50; for the 2¼-cent, $821.25; the difference in the cost for the two treatments being $821.25, which equals 5 per cent on an investment of $16,425.

2. Where necessity compels the use of troublesome water there are few cases where by treatment, either mechanically or chemically, fairly good waters for boilers may not be obtained, the important consideration being the method employed.

There are in the market numerous so-called water purifiers, purges, oils and boiler-cleaners, many of them absolutely worthless, others dangerous.

It should be a rule never to allow the use of any compound for this purpose until its effects and dangers are fully understood.

3. The cost of purifying waters will always be cheap when compared with the use of waters which cause trouble in the boiler. The best methods to be employed

can only be determined when the conditions are fully understood. The cost for water purification depends on the character of the water and the methods and reagents employed. Lime and soda ash are the cheapest of the effective and harmless reagents for this purpose, and direct treatment in the tender is the least costly method.

Waters carrying twenty-five grains of incrusting matter per gallon, five of which are sulphates, may be successfully treated with soda ash at a cost of about 40 cents per 1,000 miles of engine mileage, or about 6.12 mills per 1,000 gallons of water.

With engines equipped with blow-off cocks of sufficient number and correctly located, and with four per cent of the water taken blown out, in keeping boiler free from sludge, the engine may be safely and satisfactorily run from 2,000 to 3,000 miles between washouts.

Assuming the cost for untreated water to be 10 cents per 1,000 gallons, the 4 per cent wasted in blowing out would represent a value of 4 mills per 1,000 gallons, or a total for treatment and waste of 10.12 mills. In this calculation no account is taken of the heat losses in the water blown out, and if the blowing out be done at the end of the trip, when the engine goes into the roundhouse for a layover, it should not be. But if on the road, a further cost equal to the value of the heat in the water wasted should be added to the other expenses for water purification.

In waters of the character and treated by the methods just referred to, the results that may be expected from engines in freight service is that 100,000 to 200,000 miles may be made between changes of flues, and that the life of fire boxes will be from eight to fifteen years.

Water with forty grains of incrusting matter, seven or eight of which are sulphates, may be treated in the same manner with fairly good results, but with an additional cost for reagents and blowing out in proportion to the increase in incrusting matter and sulphate.

Treatment of water in the station tank, as represented by the several cases already alluded to, costs for reagents from 2¼ to 4½ cents per 1,000 gallons, and we estimate the loss of water in cleaning the settling tank, and in blowing out to keep the concentration of alkali to a safe limit, to be as great as by the direct method. The first cost for the water station is greater and will be further increased by the introduction of automatic devices for delivering the reagents. On the other hand, the special advantages are that the treatment may be varied to suit each particular condition of water; also that the water freed from sludge will carry a greater concentration of alkali without trouble from foaming.

The cost for treatment of water by mechanical purifiers or cleaners is for the water and heat lost in blowing out. The blow-off cock is the active agent for purification in all mechanical cleaners; the part performed by the remainder of the devices is to assist in bringing mud within its reach.

An engine fitted with blow-off cocks, as shown in Fig. 5, which is the standard on the N. Y. C. & St. L. R'y, is, we believe, fully equipped with a good purifier.

When waters contain little or no sulphates, or where alkali is troublesome or earthy matter is in suspension, they may be successfully handled by mechanical devices.

We do not consider it safe practice, where sulphates are to be dealt with, to

depend upon mechanical devices, except they be reinforced by chemical reagents for neutralizing the incrusting matter.

The cost for clarification of water by filtering or settling is for first cost of plant, the interest and maintenance of same. By the unaided method, the only other expense should be for attendant and water used in cleaning.

With the mechanical filter, the water used for this purpose should not exceed 5 per cent of the amount pumped, and the time consumed in cleaning should be about fifteen to twenty minutes every five to ten hours. Where coagulants are used, there will be an additional cost for chemicals of 1 to 2 cents per 1,000 gallons of water clarified.

The cost of water purification by evaporation, as already explained, represents the most effective practice of the day. The price given will be varied in proportion as the cost of labor and fuel be greater or less than the figures used in the case cited.

4. There should be on the staff of the Superintendent of Motive Power, where the size of the system will warrant, and boiler feed waters are troublesome, two specialists; one a boiler washing inspector, who has charge of the boiler washing. In the performance of his duties, he should as often as possible visit the different roundhouses and shops to see that they are equipped with and using the tools intended for this purpose; that the boiler washers understand how, and are doing good boiler washing; where soda ash put in the tender is the reagent and method employed for purification, to see that the correct amount is properly put in, observe the manner in which the blowing off is done, and to stay at each point until a personal inspection has been made of all boilers cared for by them.

The other specialist should be an assistant to the chemist, and should have a knowledge of the chemistry of water, and a good understanding of geology; the water supply of the system, so far as relates to quality, to be directed by him. Among his duties to be the searching for, and locating, the best sources of water, looking after the condition of water in existing stations, and where any falling off in quality develops, to determine cause. The analysis records, and reports in relation to water purification and supply, and its performance in the boilers, to be under his charge. He should spend a part of his time on the road personally inspecting pumping and purifying plants and methods, and should keep in close touch with the boiler washing inspector, roundhouses and shops.

A man of this character, with a correct understanding and well directed efforts, would make himself useful in the department, and be the means of materially lessening trouble in boilers from water impurities.

Respectfully submitted,

A. E. MANCHESTER, *Chairman*,
J. H. MANNING,
S. B. BUSH,
H. BARTLETT,
R. M. GALBRAITH,

Committee.

TABLE 2.—WATER ANALYSES—C. M. & ST. P. R'Y—LA CROSSE DIVISION.

STATION.	GRAINS PER U. S. GALLON.										POUNDS PER 1,000 GALLONS.			
	INCRUSTING SOLIDS.					NON-INCRUSTING SOLIDS.				Total Solids.	Incrusting Solids.	Sludge formed.	Alkali contained.	Soda Ash to be added.
	Oxides.	Calcium Carbonate.	Calcium Sulphate.	Magnesium Carbonate.	Total.	Alkaline Carbonate.	Alkaline Sulphate.	Alkaline Chloride.	Total.					
Milwaukee	0.09	4.40	0.31	2.08	6.88	0.00	0.28	0.28	0.56	7.44	0.98	0.90	0.08	0.160
14 Brookfield	0.06	9.56	1.59	8.78	19.99	0.00	2.24	0.59	2.83	22.82	2.86	2.47	0.40	0.526
18 Oconomowoc	0.13	11.11	1.35	7.63	20.22	0.00	0.97	1.80	2.77	22.99	2.89	2.56	0.40	0.510
14 Watertown	0.16	10.37	0.46	6.69	17.68	0.00	0.89	0.30	1.19	18.87	2.53	2.27	0.17	0.387
19 Columbus	0.12	8.54	0.87	7.43	16.96	0.00	0.19	0.17	0.36	17.32	2.42	2.12	0.05	0.406
28 Portage	0.32	2.27	0.00	1.44	4.03	0.75	0.00	0.07	0.82	4.85	0.58	0.52	0.12	0.000
17 Kilbourn City	0.32	2.27	0.00	1.44	4.03	0.75	0.00	0.07	0.82	4.85	0.58	0.52	0.12	0.000
26 New Lisbon	0.13	2.12	0.00	1.41	3.66	0.00	0.35	0.22	0.57	4.23	0.52	0.47	0.08	0.073
19 Tomah.....	0.21	4.14	0.00	3.00	7.33	0.00	0.79	0.10	0.89	8.22	1.05	0.94	0.13	0.147
17 Sparta	0.13	1.75	0.00	0.75	2.63	0.00	0.92	0.30	1.22	3.85	0.37	0.35	0.17	0.050
24 La Crosse	0.24	7.67	0.75	3.31	11.97	0.00	1.53	1.22	2.75	14.72	1.71	1.57	0.39	0.295

NOTE.—"Oxides" includes Silica, Alumina and Oxide of Iron. Figures in first column indicate miles between stations.

THE PRESIDENT: Gentlemen, the report is before you; what is your pleasure?

MR. F. A. DELANO: I move that the report be received.

The motion was carried.

THE PRESIDENT: The motion included placing it on the minutes, of course, which will be done. Gentlemen, I have allowed Mr. Manchester considerable time to go over this, and perhaps I might say now that it was largely on account of his size that I did it, but no other member will be allowed to exceed ten minutes in presenting a paper unless there is a recommendation from the floor. This is a very important topic. It is an admirable paper. It is one that surely will be conducive to excellent results if followed closely, one that will admit of a good deal of close study. I think these gentlemen ought to be thanked by the Association for going into it so deeply and thoroughly. Now the paper is before you and open to discussion. I hope you will be prompt and quick to respond.

MR. H. J. SMALL: Mr. President, I think with you that the Association is to be congratulated on the receipt of this report which is so full and exhaustive that it leaves very little room for criticism. I wish, though, to relate a little experience we had with the method of treating water by placing soda ash in the tenders of locomotives. Some few years ago we adopted the pumping-station method of treating water; but as we were rather slow getting them in, we finally decided to try the soda ash treatment in tenders, as was practiced on the Chicago, Milwaukee & St. Paul road. But we failed to get the same success that they evidently did on that road, probably due to the fact that the character of the water differs very greatly in short distances. At one station there would probably be a very large amount of alkali. At the very next station there would be a preponderance of the very material we were putting into the tenders — soda ash. It resulted in excessive blowing off of the boilers and foaming, causing very considerable delay in the service, so that some months ago I took it off; we stopped its use, with the result that the fuel consumption showed a very decided decrease during those months that it was off. But we came to the conclusion after a great deal of experience and trial of various compounds that were guaranteed to cure any kind of water, that the pumping-station method was the best and cheapest. I notice that the committee speak of the large expense of the fitting up these stations. But the cost is not very great. We have established

four of them, and I do not think any one cost over $1,500. The location, of course, has a good deal to do with the cost, the manner in which you can locate the settling tanks, etc.

This method of treating water at the stations, before it is put into the locomotive boiler, was very thoroughly discussed by the American Society of Mechanical Engineers at their last annual meeting. One of the prominent members of that society, in concluding a very able and long discussion, had this to say: "In conclusion, I would say that if this discussion has raised a question of doubt in the minds of any of the gentlemen present as to the ability of this form of apparatus to perform its work satisfactorily, easily and economically, I will say that such doubt may be dismissed at once, as this process is a very efficient and desirable one, and it is one very largely used in England, France, Germany, Austria and Belgium, while here in America we are just rubbing our eyes and waking up to appreciate the very material saving which it affords in prolonging the life of the boiler, in saving fuel and in reducing our bills for cleaning boilers." I have no doubt whatever that the report of this committee will result in a great deal of good, as I have no doubt that a great many sections of the country, as with us, have probably given up the hope of finding any better way, and have got to do the best they can in the way of purification.

MR. F. A. DELANO: Mr. Chairman, I want to add one suggestion to this very valuable compilation, of a method of treating feed water, a method which is in use to some extent, I know, in Europe and England, and I think to some extent in this country. Perhaps some of the members here can tell us more about it than I can. I refer to the method of treating the feed water by waste steam — exhaust steam — in order to raise the temperature, and by raising the temperature precipitating a good many of the impurities. As you are all aware, the only reason that the lime salts are held in solution in water is the existence of a carbonic oxide in the water, which is gotten rid of as soon as the temperature of the water is raised close to the boiling point. The committee speaks of a method used on the Red Sea of distilling water. Of course it is obviously a great deal cheaper to simply heat the water nearly to the boiling point than it is to distil it, and at a great many shop points, it occurs to me, there is steam going to waste which if turned into a reservoir, would be very effective in throwing down these lime salts that are giving so much trouble.

MR. J. N. BARR: Mr. Chairman, we all agree that this is an

important matter, and we all have the idea that certain materials can be used in boilers to advantage with bad water, while ten or fifteen years ago we all were agreed here that the thing was no good. I am glad to see the change. Too many persons have demonstrated that work can be done in this direction. However, on looking over the paper, I think there is one side of the question to which the committee has scarcely given sufficient attention, and that is, while all these methods are good, it will require considerable discussion and calibrating in order to prove which is the best; but none of them are good if they are not followed out properly, and if the necessary attention is not given to cleaning the boilers. Unfortunately the subject is almost too big to treat exhaustively in a paper of this kind, but our experience has been that while the general idea we started on ten or twelve years ago was all right when we first started, we carried it out in mighty poor style, and we had to learn for a good many years and do a great deal of teaching before we got our men any way near to carrying the processes out properly. Any one who has not made a strong endeavor in that direction is unable to appreciate the difficulty that we encountered. We had to suspend men, suspend the boiler washers because they did not carry out our instructions, and I will say right today that we are yet very far from doing the work properly.

PROF. H. WADE HIBBARD: Mr. President, with reference to Mr. Delano's remarks about heating feed water by exhaust steam, it should be borne in mind that exhaust steam contains oil, and if you heat your feed water by exhaust steam it should be heated by the exhaust steam passing through coils of pipe, so as to prevent the oil in the exhaust steam getting into the feed water; or else, if you do run your exhaust steam directly into the feed water, and so get the feed water oily, you would need to extract that oil from the feed water as proposed, by running the oily feed water through a chamber, containing hay or bagging, or some material of that sort. It is well known that oily feed water will produce a deposit in a boiler, on the crown sheet, around the tubes or on the under side of the tubes, which is far more dangerous than a deposit of lime or magnesia; a sixteenth of an inch of oily deposit is far more dangerous than a considerably greater thickness of other material in preventing the passage of heat from the boiler steel to the water. The oily feed water seems to produce a floating pancake, as it were, of oil,

which collects to itself the insoluble precipitates, as of lime and magnesia, until finally it settles down and forms that coating on the sheet, or even on the underside of the boiler tubes, which is so impervious to the passage of heat.

MR. H. A. GILLIS: I do not know that I can add anything to the information contained in this paper, or the remarks that have been made, but there is one thought that has suggested itself to me which I think possibly is worthy of attention, and that is, after looking over this paper and seeing what a valuable one it is — after all, does not the transportation department deserve some credit for this paper? Has it not been the result of the pressure brought on us to get our engines out and keep them in service? One of the greatest bugbears I had in the Master Mechanics department was the fact that I was not allowed sufficient time to clean my boilers properly. Has not that been the case with all of us, and have we not all felt pretty hard sometimes toward the Division Superintendent or transportation officers, because we did not have the opportunity we thought we should have had? But the result is that we are now learning something. We have been forced into this situation. We are improving, and improving not only the mechanical side, but the transportation side. Merchandise is transported more expeditiously by saving the time that we used to waste in our old method of boiler work.

MR. JOHN MACKENZIE: Nothing has been said about the water that we do not treat. There are a great many roads that have water that does not require treatment. We have some water on our line that we do not treat, but we find that we get a good deal of scale on the flues, and yet we can run them a great deal longer than we can on the other division. But what we find gives us more relief than anything else is the use of the blow-off cock — the proper use of the blow-off cock, and knowing when to use it; and in connection with the blow-off cocks, perforated pipes in the boiler, so that we cover quite a lot of ground with these perforated pipes and draw from the boiler as it should be drawn from. In the bottom of the boiler we run a perforated pipe from the front flue sheet nearly the whole length of the boiler, and a two-inch cock is used. We naturally supposed those holes might stop up after a while, but they do not, and we get a great deal of sludge out of the boilers by the use of the cock in that way, particularly on the divisions where we do not treat the water. With us it is simply a matter now of sounding the stay bolts, or testing the

boiler once a month. We are using in connection with these perforated pipes what is known as the Ruby oil treatment. It is fed in just the same as we feed the oil into the cylinders. I understand on the Erie road with that system they have increased the mileage of their engines twenty-three per cent. In other words, if they had not introduced this treatment on their line, during the last year they would have had to buy some 150 or 200 engines to have done the business, something like that, I think. With us we have been running two passenger engines equipped with this treatment about 5,000 miles between washings, and when they are washed the plugs are taken from the front flue sheet, also from the back flue sheet, and the barrel of the boiler thoroughly rinsed out. We find, in connection with that pipe, not one particle of mud around it, but all the scale that falls down is drawn up close to the pipe, and easily removed by washing from the front end.

About blowing out, I would not wait too long when the engine gets in. Our rule is that the moment the engine is put on the ash pit the surface blowers are opened, and we do not blow too much, either; a minute and a half is plenty. We get all the stuff there is around the pipe that we can draw off in a minute and a half. Then we say to the engineer, "You look your engine over, and in the meantime let the water be settling toward your lower blow-off cock, and after you have looked your engine over, get up and open your blow-off cock, first the bottom of the boiler and then the leg of the boiler." On these engines we have five cocks. The blow-off cocks on the leg of the boiler stand out on the top of the wagon top. The pipes lead down between the stay bolts and the lower pipe, and we raise the sludge and stuff up through those pipes and out through the blow-off cock. There is one thing that I want to call attention to in connection with blow-off cocks, and that is, when you have the cocks up high on the boiler, you do not have to make half the repairs that you did before; in fact, we do not make any repairs at all on them now. The seats do not cut out, and we have great deal better results from the blow-off cocks.

MR. ATKINSON: I would like to ask Mr. Mackenzie a question. He said he opened the blow-off cocks a minute and a half. I would like to ask about what volume of water he passed out in that time — a gauge glass or more?

MR. MACKENZIE: Our instructions are to blow out a gauge and

a half of water. The engineer has instructions to bring the engine in with a full boiler of water, as clean a fire as possible, and a full pressure of steam, and the boiler is not used while the engine is being blown out. The injectors are not used until after everything is finished. Then the engine is allowed to stand until the steam gets up to the blowing off point, and the injectors are then put on.

MR. W. S. MORRIS: I have read this paper with a great deal of interest, and I have gained a great deal of information which I certainly did not have before. Ours is one of the roads that is not troubled with bad water. In fact, we have some water on our lines which is too good, which indicates that the treatment of water is all right. We were obliged to abandon one tank that only had about three and a half grains of solids to the gallon, simply because it acted on the boiler plates. On some other parts of our line we have the Ohio river water; the solids are mechanically mixed — mud; sludge it is called in the report. I think that the system of blowing off is a good one for that territory. Some two or three years ago when this subject was up, there was a purifier called the Barnes purifier, which was very prominent in the report, and I notice in this report the standard of the New York, Chicago & St. Louis Railroad, which seems to answer every purpose the other did, with considerably less mechanical construction or arrangement. I would like to ask the Chairman if there is any patent on this one that is illustrated. It seems to me that it would answer the purpose admirably for all water that is bad on account of the solids being mechanically mixed.

MR. MANCHESTER: I would ask Mr. Mackenzie to answer the gentleman.

MR. MACKENZIE: What was the question?

MR. MORRIS: I would like to know if this combination is patented.

MR. MACKENZIE: Not that I know of. We have been using it since 1895.

MR. MORRIS: It is the property of any one who wants to use it?

MR. MACKENZIE: Anybody can use it, I believe.

MR. MORRIS: Thank you. That is a good point.

MR. MCINTOSH: Referring to the recommendations of the committee at page 21, describing the engine on the New York, Chicago & St. Louis, and also referring to Mr. Mackenzie's remarks about the value of perforated pipes, I would say that so far as my experience goes these pipes are of no particular value. The benefit is derived from the number of blow-off cocks and their location. The natural circulation of the water will carry the impurities to the blow-off cocks. With reference to using the surface blow-off cock at the ash pit, I am of the opinion that that is of no benefit, because whatever has been on the surface has settled before that time arrives. In my experience the surface blow-off cock should be used when the engine is at work; the harder the better. Then whatever precipitate there is is being carried with the circulation of the water upward and forward to the front part of the boiler, where a connection to the blow-off cock in the shape of a scoop would gather it all and carry it off.

Referring to Mr. Small's difficulty in the way of the loss of fuel in blowing off his engines, I am of the opinion that he has not used that system long enough to determine its value. In other words, when blow-off cocks are first introduced men are too apt to use them without judgment, blowing off indiscriminately, and of course in doing so, wasting fuel. The best effects are derived by opening the surface cocks for short periods and frequently — when the engine is working hard — and in this connection it is desirable to train men very carefully to use them properly.

MR. HANGLIN: The road with which I am connected is troubled with bad water, and I would like to ask Mr. Mackenzie if he keeps his pressure on the boiler in blowing out that gauge and a half of water, and if he has any trouble in regard to making the flues leak.

MR. MACKENZIE: No sir; we have no trouble. In fact we do not have any leaky flues any more. We used to have a great many leaky flues. Now we do not have any. In connection with Mr. McIntosh's remark about the perforated pipes I agree with him that a perforated pipe is useless unless it is put in right. We know that perforated pipes were used for purging boilers many many years ago, but when they perforated the pipes they put all the holes in they could get, and the consequence was that about a foot from the blow-off cock, the result would be the same as if there was no pipe at all — all the holes would be stopped up. What is wanted is a pipe with holes enough

that will form a vacuum in the pipe with the blow-off cock, so that it will draw equally with the whole line of your pipe, and we know that it is a benefit, because we have run the engines without the pipes and we have run them with the pipes, and in those without the pipes, the blow-off cock will take care of about a foot in the neighborhood of the cock, and in the ones with the pipes in it will take care of the whole length of the boiler. There is not mud enough to stain a piece of white paper after the engine has been blown off after running 5,000 miles.

MR. ANGUS SINCLAIR: Mr. President, I consider this report a very good paper on the prevention of scale from boilers, and I have given a good deal of attention to the subject. I think, however, that its greatest value will be of an educational character and for spreading the news that the thing can be done if it is persisted in. The history of water purification has been that it would be tried indifferently, it would be tried with chemicals indifferently; there was no one particularly interested in making it a success; they would take mechanical appliances and give them to the men and say, "Work that and it will be all right." The men did not work them, and in a short time the whole thing was thrown out—no good. There is nothing that can prevent the forming of scale with bad water. What you want is good water. Yet there has never been any systematic attempt carried on in the country, as a whole, to get good water, or to get as good water as possibly could be had on the road. Over twenty years ago I was appointed water analyst of a certain road in the West, and the general manager said that he wanted to find out where the particularly bad water was on that road, and try to select better water if possible. The first inquiry I made was where the greatest trouble was with the feed water. They said it was at Burlington. I went there and examined the water station. I found they had a deep well through limestone that was highly charged with sulphuric acid, with sulphate of lime, and it was only about forty feet from the banks of the Mississippi river, which is good water. I directed that they abandon that well at once. It was done that same afternoon I was there, and the pipes were put out into the river, and there never was any more trouble at that place with the fire boxes of the switching engines, which previously could scarcely ever be kept tight. I went over the entire road in the same way, and found there were many places where good water could be had if the locating engineers had paid any attention to locating the tanks at the places where soft water

was to be had. The thing has been agitated so very much since that time that I thought locating engineers had been informed, as well as Master Mechanics, about the evils of bad water, but I find that they have not got the news about the effects of bad water; it has not gone to that department as it should do. On a road that was built in the West about seven years ago, where there were fair opportunities for the selection of good water, the tanks were located along the line of road certain distances apart, no attention whatever being paid to the character of the water to be obtained, and last summer the same company was relocating the tanks to try to rectify the mistake that the original engineers had made. Now that is still going on today; that is a thing that happened seven years ago, and new roads that are being located today are having water tanks located just as ignorantly as they were over twenty years ago, when there was scarcely any agitation on this subject. Gentlemen, you should get your general officers to learn something about the effects of bad water. (Applause.)

THE PRESIDENT: Are there others who have not spoken to this question who wish to speak? Has Mr. Dunn, of the Oregon Short Line, a word? If not, I will accord Mr. McIntosh a minute.

MR. MCINTOSH: I just want to say, Mr. President, that we have on record reports of engines equipped with four blow-off cocks that compare very favorably with Mr. Mackenzie's perforated pipes, and there were no perforated pipes in connection with them.

THE PRESIDENT: Gentlemen, if there are no further remarks the discussion is closed. We will now proceed with Report No. 3, "Relative Merits of Cast-Iron and Steel-Tired Wheels for Locomotive and Passenger Car Equipment." Mr. J. N. Barr, the chairman of that committee, will present the report.

Mr. Barr presented the following report:

REPORT OF COMMITTEE ON RELATIVE MERITS OF CAST-IRON AND STEEL-TIRED WHEELS FOR LOCOMOTIVE AND PASSENGER CAR EQUIPMENT.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee appointed to report on the above would say:

In order to secure as much definite information as possible, the following Circular of Inquiry was issued:

"To the Members of the Master Mechanics' Association:

"Your committee appointed to report on 'The Relative Merits of Cast-Iron and Steel-Tired Wheels for Locomotive and Passenger Car Equipment' request the following information:

"*First.*— Average mileage, in case an individual mileage record is kept, for cast-iron or steel-tired wheels under passenger cars, engine trucks or tenders, as per Statement No. 1. A separate statement should be made for the different classes of wheels; for instance, one of the No. 1 statements should be filled out showing the average mileage of cast-iron wheels 33 inches in diameter removed from passenger cars, engine trucks and tenders; a second statement should be made for the average mileage of steel-tired wheels 33 inches in diameter removed from passenger cars, engine trucks and tenders, and, if wheels of different diameters are used, additional statements should be made out to cover.

"Statement No. 2 is intended to provide for cases in which a regular individual record is not kept. In this case, the number of new wheels of one kind bought for repairs to cars during the year is given.

"*Second.*— The total mileage of the same kind of wheels reported in column No. 1. This is obtained by taking the mileage of cars equipped with such wheels for a year and multiplying by the number of wheels under the cars; for instance, if a car equipped with 38-inch steel-tired wheels makes 50,000 miles in a year, and has six-wheel trucks or twelve wheels under it, the mileage will be twelve times 50,000 or 600,000 miles for that car, and the sum total will give the total mileage of that class of wheels during the year.

"Column No. 3 simply reports the number of cars, tenders or engines equipped with that particular size and kind of wheel.

"Column No. 4 gives the total number of that class of wheel in service.

"Column No. 5, 'Average Mileage,' is obtained by dividing the total mileage in column No. 2 by the number of wheels bought or used in column No. 1.

"In statements made out for cast-iron wheels, the words 'steel-tired' should be erased, and vice versa.

"If the mileage can be given as called for in Statement No. 1, there will be no occasion for filling out Statement No. 2.

"In addition to the above, please furnish the following information:

"1. Cost of cast-iron wheels, new.

"2. Value of cast-iron wheels, scrap.

"3. Cost of steel-tired wheels, ... diameter, new.

"4. Value of steel-tired wheels, ... diameter, scrap.

"5. Average number of turnings and cost per turning for life of wheels.

"6. State the number of cases of breakage per 1,000 wheels in service for the years covered by the statements.

"7. Give cost per 1,000 miles of service for the different classes of wheels.

"8. Any general remarks as to the advantage of cast-iron wheels over steel-tired wheels, and vice versa.

"9. If you have noticed any difference in the different makes of steel-tired or cast-iron wheels, report the same. It is not necessary to do this by mentioning names, but the makes should be designated by letter, and will be so designated in the committee's report.

"Please send replies to J. N. Barr, Superintendent Motive Power, C. M. & St. P. R'y, West Milwaukee, Wisconsin.

"J. N. BARR, Chairman,
"H. S. HAYWARD,
"A. M. WAITT,
"*Committee.*"

To this circular ten replies were received, two of which gave mileage information which is embodied in the attached nine statements.

These two reports were furnished by the Lake Shore & Michigan Southern and Chicago, Milwaukee & St. Paul Railways.

Two roads, the Chicago, Burlington & Quincy and Norfolk & Western Railways, gave some information, which will be referred to hereafter.

The other replies were in the nature of regrets.

The Norfolk & Western R'y reports that cast-iron wheels are used exclusively except in the case of engine trucks. Here steel-tired wheels are used as a matter of safety. The price of a 600-pound cast-iron wheel is $4.85 as made by this company. This price does not include cost of superintendence or repairs of buildings.

The Chicago, Burlington & Quincy Railway, through Mr. G. W. Rhodes, says: "It has always been our practice to advocate cast-iron wheels made to Master Car Builders' specifications and tests when they do not exceed 33 inches in diameter, as being the cheapest wheel to use, and as safe a wheel as any steel-tired wheel." One exception is made to this: For engine trucks steel-tired wheels are used, as they are considered less liable to have broken flanges. For wheels larger than 30 inches diameter, it is thought steel-tired wheels should be used, but have a number of 37-inch cast-iron wheels in service with no indications of breakage. In the last few months this road had two steel-tired wheels broken, one of which derailed a car. Tire was fastened by a Gibson retaining ring. A similar case has occurred with a cast-iron wheel recently.

The Lake Shore & Michigan Southern Railway, through Mr. Stevens, in addition to the information given on the statements, reports as follows: Average number of turnings for steel-tired wheels is two, and cost $1.25; steel-tired wheels are safer than cast-iron wheels; otherwise the relative merits are about the same.

The Lake Shore & Michigan Southern Railway, through the General Master Car Builder, report in addition to data given in statements: Cost of turning steel-tired wheels, $1.62 per pair; average number of turnings, 4.

The Chicago, Milwaukee & St. Paul Railway report, in addition to data given in statements, as follows: Cost of turning steel-tired wheels, $1.85 per pair; average number of turnings, 4. Steel-tired wheels are safer than cast-iron wheels for engine trucks, on account of tendency of these wheels to breakage of flanges. For all other service, their experience has been that cast-iron wheels are safer than steel-tired wheels. The actual number of breakages of such a character as would derail a car is greater for steel-tired wheels than for cast-iron, although about ten times as many cast-iron wheels as steel-tired wheels are in service. Steel-tired wheels are more expensive in both passenger car and locomotive service. The cost per 1,000 miles for steel-tired wheels is more than three times as great as for cast-iron wheels.

Your committee regrets that more information based on actual records was not furnished, as conclusions on this subject should be based on facts and not on unsubstantiated opinions. It should be remembered that the item of wheel service is the most expensive single item with which we have to contend. The mileage obtained from the best cast-iron wheels is fully three times as great as the poorest. The factor of safety in favor of the best cast-iron wheels as compared with the poorest bears at least an equal proportion. The same relation as to breakage exists as to steel-tired wheels. While the mileage relations of the various steel-tired wheels approaches

much nearer to uniformity, it is not believed that this would be the case if the manufacture of steel-tired wheels were exposed to the same unbridled competition as is the case with cast-iron wheels. Again, the safety of trains from disaster, and even the life of human beings, is so dependent upon the quality of the wheels used that it would seem that railroads would not ignore the necessity of keeping a close watch and a full record of cases of breakages, with a view of eliminating from service wheels of doubtful quality. If it has been demonstrated that steel-tired wheels are safer than cast-iron wheels, railroads cannot afford to ignore this fact, and are without excuse for accidents arising from breakages, at least under passenger cars and locomotives, if the same are caused by breakages of cast-iron wheels, no matter what the difference in cost may be. If, however, there is no difference in the matter of safety, then the cost should decide the question. In the case of wheels, first cost is very far from deciding what is the most economical. Relative durability must always be taken into consideration. This can be done most definitely by keeping an individual record of wheels used and removed, and the actual mileage of the cars under which the wheels made their service. This method is cumbersome and many roads hesitate in going to the expense of maintaining such a record. The same results, however, can be approximated much more simply and with little labor by the following method: Make record, for example, of all tenders running with thirty-three-inch cast-iron wheels; also of all wheels removed from these tenders during the year; obtain the mileage of these tenders for the same period and multiply by eight to obtain the total wheel mileage; divide this sum by the number of wheels removed, and the result will approximate closely with the actual wheel mileage obtained. While this method omits many details of importance, it gives actual results as a whole, and is much better than no information whatever.

Turning now to the statements presented with this report, the first six explain themselves and call for little or no remarks.

Statements Nos. 7 and 8 give the relative breakage of steel-tired and cast-iron wheels. There is considerable discrepancy in these reports; the L. S. & M. S. Railway report shows very much in favor of steel-tired wheels; the C. M. & St. P. Railway report shows in favor of the cast-iron wheels.

With the information as presented, your committee is unable to draw any definite conclusion, and would say that further information is required.

As to the comparative cost, as shown on Statement No. 9, there is a decided discrepancy in the cost per 1,000 miles in passenger car service, partly due to difference in average mileage and partly to difference in relative value of new wheels and scrap. For locomotives the two reports agree much more closely, and if the discrepancies due to difference between cost of new and scrap wheels were removed the cost of service both for cast-iron and steel-tired wheels would be very close indeed, showing in both cases much in favor of cast-iron wheels.

Your committee is of the opinion that the various members of this Association possess much more information both as to breakage and cost than they have been able to present, and trust that members will come prepared to add considerable in the way of actual facts to what they have been able to present.

In conclusion, your committee would say:

First — It is not able to decide from the facts presented whether steel-tired wheels are safer than cast-iron wheels, except in case of engine trucks.

Second — For engine trucks it would recommend steel-tired wheels from considerations of safety.

Third — Cast-iron wheel service is cheaper than that obtained from steel-tired wheels.

Fourth — It would recommend that at least the method detailed above be used for determining wheel mileage.

Fifth — That a careful record of breakages be inaugurated and maintained.

J. N. BARR, Chairman,
H. S. HAYWARD,
A. M. WAITT,
Committee.

STATEMENT No. 1.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

AVERAGE MILEAGE OF CAST-IRON WHEELS, 33 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894	710	56,794	1894.....	1,166	48,223
1895	606	53,677	1895.....	1,105	44,270
1896	539	54,386	1896.....	978	44,398
1897	436	51,853	1897.....	762	44,317
1898	670	52,325	1898.....	1,049	43,761
ENGINE TRUCKS.					
1894			1894.....		
1895			1895.....		
1896			1896.....		
1897			1897.....		
1898			1898.....		
TENDERS.					
1894	1,475	64,126	1894.....	1,523	61,513
1895	1,259	62,355	1895.....	1,344	60,269
1896	1,109	63,047	1896.....	1,196	61,583
1897	1,260	67,087	1897.....	1,321	65,813
1898	1,372	63,681	1898.....	1,433	62,131

STATEMENT No. 1.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

AVERAGE MILEAGE OF CAST-IRON WHEELS, 33 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894	2,387	109,999	1894	3,450	89,235
1895	2,194	110,127	1895	3,011	93,219
1896	2,630	111,215	1896	3,356	95,568
1897	3,139	105,250	1897	4,390	84,143
1898	2,691	103,434	1898	3,901	83,080

ENGINE TRUCKS.

1894	None.		1894	None.	
1895			1895		
1896			1896		
1897			1897		
1898			1898		

TENDERS.

1894	2,311	80,236	1894	2,719	78,770
1895	1,856	79,950	1895	2,089	75,980
1896	2,017	88,521	1896	2,276	82,464
1897	1,973	88,357	1897	2,196	78,171
1898	2,280	95,864	1898	2,741	86,793

STATEMENT No. 2.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

AVERAGE MILEAGE OF CAST-IRON WHEELS, 30 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894.....			1894.....		
1895.....			1895.....		
1896.....			1896.....		
1897.....			1897.....		
1898.....			1898.....		

ENGINE TRUCKS.

1894.....			1894.....		
1895.....			1895.....		
1896.....			1896.....		
1897.....			1897.....		
1898.....			1898.....		

TENDERS.

1894.....	684	74,611	1894.....		
1895.....	700	73,631	1895.....		
1896.....	590	71,876	1896.....		
1897.....	703	72,718	1897.....		
1898.....	767	72,518	1898.....		

STATEMENT No. 2.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

AVERAGE MILEAGE OF CAST-IRON WHEELS, 30 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Removed.	Year.	Total Number Removed.	Average Mileage.
1894			1894.....		
1895			1895.....		
1896	None.		1896.....	None.	
1897			1897.....		
1898			1898.....		

ENGINE TRUCKS.

1894			1894.....	616	70,315
1895			1895.....	527	70,795
1896			1896.....	504	73,118
1897			1897.....	519	78,653
1898			1898.....	473	83,271

TENDERS.

1894	51	69,145	1894.....	53	68,848
1895	31	57,504	1895.....	32	57,546
1896	30	106,255	1896.....	32	102,654
1897	28	77,741	1897.....	28	77,741
1898	53	103,139	1898.....	58	98,299

STATEMENT No. 3.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

AVERAGE MILEAGE OF CAST-IRON WHEELS, 28 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894			1894.....		
1895			1895.....		
1896	None.		1896.....	None.	
1897			1897.....		
1898			1898.....		

ENGINE TRUCKS.

1894			1894.....	287	65,137
1895			1895.....	210	62,291
1896			1896.....	163	64,326
1897			1897.....	178	68,462
1898			1898.....	165	66,052

TENDERS.

1894			1894.....		
1895			1895.....		
1896	None.		1896.....	None.	
1897			1897.....		
1898			1898.....		

STATEMENT No. 3.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

AVERAGE MILEAGE OF CAST-IRON WHEELS, 28 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894.....			1894.....		
1895.....			1895.....		
1896.....	None.		1896.....	None.	
1897.....			1897.....		
1898.....			1898.....		

ENGINE TRUCKS.

1894.....			1894.....	612	53,267
1895.....			1895.....	494	57,888
1896.....			1896.....	549	58,433
1897.....			1897.....	444	60,278
1898.....			1898.....	539	63,892

TENDERS.

1894.....			1894.....		
1895.....			1895.....		
1896.....	None.		1896.....	None.	
1897.....			1897.....		
1898.....			1898.....		

STATEMENT No. 4.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

AVERAGE MILEAGE OF STEEL-TIRED WHEELS, 33 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894.....			1894.....		
1895.....			1895.....		
1896.....			1896.....		
1897.....			1897.....		
1898.....			1898.....		

ENGINE TRUCKS.

1894.....			1894.....		
1895.....			1895.....		
1896.....	None.		1896.....	None.	
1897.....			1897.....		
1898.....			1898.....		

TENDERS.

1894.....	10	200,988	1894.....		
1895.....	42	380,458	1895.....		
1896.....	82	345,325	1896.....	None.	
1897.....	74	350,722	1897.....		
1898.....	60	361,336	1898.....		

STATEMENT No. 4.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

AVERAGE MILEAGE OF STEEL-TIRED WHEELS, 33 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894			1894.....	94	341,994
1895			1895.....	78	316,617
1896			1896.....	39	356,554
1897			1897.....	31	310,806
1898			1898.....	41	308,209

ENGINE TRUCKS.

1894			1894		
1895			1895.....		
1896	None.		1896.....	None.	
1897			1897.....		
1898			1898.....		

TENDERS.

1894			1894.....		
1895			1895.....		
1896	None.		1896.....	None.	
1897			1897.....		
1898			1898.....		

STATEMENT No. 5.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

AVERAGE MILEAGE OF STEEL-TIRED WHEELS, 36 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894.....			1894.....	146	486,956
1895.....			1895.....	134	455,897
1896.....			1896.....	198	498,726
1897.....			1897.....	139	503,893
1898.....			1898.....	98	479,344

ENGINE TRUCKS.

1894.....			1894.....		
1895.....			1895.....		
1896.....	None.		1896.....	None.	
1897.....			1897.....		
1898.....			1898.....		

TENDERS.

1894.....	.....	.....	1894.....		
1895.....	10	214,298	1895.....		
1896.....	20	374,807	1896.....	None.	
1897.....	18	327,719	1897.....		
1898.....	34	341,570	1898.....		

STATEMENT No. 5.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

AVERAGE MILEAGE OF STEEL-TIRED WHEELS, 38 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894			1894		
1895			1895		
1896			1896		
1897			1897	16	362,922
1898			1898	18	481,036

ENGINE TRUCKS.

1894			1894		
1895			1895		
1896	None.		1896	None.	
1897			1897		
1898			1898		

TENDERS.

1894			1894		
1895			1895		
1896	None.		1896	None.	
1897			1897		
1898			1898		

STATEMENT No. 6.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

AVERAGE MILEAGE OF STEEL-TIRED WHEELS, 42 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894.....			1894.....	72	596,869
1895.....			1895.....	74	524,923
1896.....			1896.....	50	548,719
1897.....			1897.....	80	504,948
1898.....			1898.....	62	496,625

ENGINE TRUCKS.

1894.....			1894.....		
1895.....			1895.....		
1896.....	None.		1896.....	None.	
1897.....			1897.....		
1898.....			1898.....		

TENDERS.

30-INCH STEEL TIRES ON L. S. & M. S. R'y.

1894.....	4	286,184	1894.....		
1895.....	42	358,432	1895.....		
1896.....	38	315,721	1896.....	None.	
1897.....	18	267,229	1897.....		
1898.....	30	246,309	1898.....		

STATEMENT NO. 6.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

AVERAGE MILEAGE OF STEEL-TIRED WHEELS, 42 INCHES DIAMETER, REMOVED FROM

PASSENGER CARS.

ALL SCRAPPED EXCEPT SLIDING.			ALL SCRAPPED.		
Year.	Total Number Removed.	Average Mileage.	Year.	Total Number Removed.	Average Mileage.
1894			1894	34	466,598
1895			1895	21	437,405
1896			1896	16	460,811
1897			1897	9	444,091
1898			1898	36	552,372

ENGINE TRUCKS.

1894			1894		
1895			1895		
1896	None.		1896	None.	
1897			1897		
1898			1898		

TENDERS.

1894			1894		
1895			1895		
1896	None.		1896	None.	
1897			1897		
1898			1898		

STATEMENT NO. 7.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

NUMBER OF WHEELS IN PASSENGER CAR SERVICE, AND NUMBER OF CASES OF BREAKAGE PER 1,000 WHEELS.

CAST-IRON.

Year.	Number of Wheels in Service.	Breakages.		Number of Cases of Breakage per 1,000 Wheels.	
		Wear and Tear.	Derailment.	Wear and Tear.	Derailment.
1894.....	6,760	4	0	0.59	0
1895.....	6,810	21	5	3.08	0.73
1896.....	6,940	8	1	1.17	0.14
1897.....	7,030	16	1	2.28	0.14
1898.....	7,140	10	4	1.40	0.56
STEEL-TIRED.					
1894.....	910	10	2	10.99	2.20
1895.....	820	25	0	30.49	0
1896.....	700	4	0	5.71	0
1897.....	620	6	0	9.68	0
1898.....	570	6	0	10.53	0

Lake Shore & Michigan Southern reports steel-tired wheels broken, none; cast-iron, 303 during last year.

STATEMENT NO. 8.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

NUMBER OF WHEELS IN ENGINE SERVICE, AND NUMBER OF CASES OF BREAKAGE PER 1,000 WHEELS.

CAST-IRON.

Year.	Number of Wheels in Service.	Breakages.		Number of Cases of Breakage per 1,000 Wheels.	
		Wear and Tear.	Derailment.	Wear and Tear.	Derailment.
1894.....	9,436	9	6	0.95	0.64
1895.....	9,256	10	11	1.08	1.18
1896.....	9,236	36	17	3.90	1.84
1897.....	8,756	21	9	2.40	1.03
1898.....	8,072	22	7	2.73	0.87
STEEL-TIRED.					
1894.....	416	2	0	4.81	0
1895.....	436	3	0	6.88	0
1896.....	536	9	0	16.79	0
1897.....	920	4	0	4.35	0
1898.....	1,388	3	2	2.16	1.44

Lake Shore & Michigan Southern reports steel-tired wheels broken, none; cast-iron, 3 per 1,000.

STATEMENT No. 9.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.

COMPARATIVE COST OF SERVICE, PER 1,000 MILES, OF STEEL AND CAST-IRON WHEELS.

Kind of Wheel.	Class of Service.	Cost, New.	Value of Scrap.	Net Cost.	All Scrapped Except Sliding.		All Scrapped.	
					Mileage in Thousands.	Cost per 1,000 Miles in Cents.	Mileage in Thousands.	Cost per 1,000 Miles in Cents
33-inch cast-iron.....	Passenger	$ 6.85	$2.62	$ 4.23	.....	.....	.....	9.40
" "	Locomotive ..	6.75	4.21	2.54	62	.....	62	4.10
30-inch "	" ..	5.75	4.14	1.61	.....	.....	73	2.21
28-inch "	" ..	5.35	3.55	1.80	.....	.....	.....	2.77
42-inch steel.....	Passenger	67.32	5.00	.....	.....	.....	.....	11.98
36-inch "	"	50.63	5.00	.....	.....	.....	.....	9.71
33-inch "	Locomotive ..	54.00	5.00	49.00	.....	.....	328	15.25

STATEMENT No. 9.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.

COMPARATIVE COST OF SERVICE, PER 1,000 MILES, OF STEEL AND CAST-IRON WHEELS.

Kind of Wheel.	Class of Service.	Cost, New.	Value of Scrap.	Net Cost.	All Scrapped Except Sliding.		All Scrapped.	
					Mileage in Thousands.	Cost per 1,000 Miles in Cents.	Mileage in Thousands.	Cost per 1,000 Miles in Cents.
33-inch cast-iron.....	Passenger	$ 5.50	$3.00	$ 2.50	108	2.31	89	2.81
" "	Locomotive ..	5.50	3.00	2.50	87	2.87	80	3.13
30-inch "	" ..	5.13	2.80	2.33	J. J. 83	2.81	81	2.89
					E. T.	.....	75	3.11
28-inch "	" .	4.75	2.59	2.16	E. T.	.....	59	3.66
42-inch steel.....	Passenger	51.00	5.00	46.00	.....	.....	471	9.77
38-inch "	"	47.00	5.00	42.00	.....	.....	422	9.95
33-inch "	"	41.00	5.00	36.00	.....	.....	327	11.04

MR. BARR: We received three replies giving information. One of those replies was received too late to be incorporated in this report. I know personally that information of this kind is kept by a great many railroads, and it is a question that can only be settled by actual record, that is, whether steel-tired wheels are safer than cast iron. You can argue about the relative qualities of those two metals until you are blind, and it is not going to tell you whether a steel-tired wheel is safer than a cast-iron wheel for the service that it is exposed to, but we certainly have a great many facts, and I hope that those facts will be presented in the future.

THE PRESIDENT: Gentlemen, you have the report. What is your pleasure?

MR. MORRIS: I move that the report be accepted and the committee continued, and that the report be placed in our Proceedings.

The motion was carried.

THE PRESIDENT: The report is now open for discussion, gentlemen. If there is no one who wishes to discuss the subject, we will proceed to the next topic. I do not want to do that, however, without giving you all a chance to speak to the question.

PROFESSOR HIBBARD: I know that on some roads in passenger service, the four-wheel tender truck has the leading axle with steel-tired wheels, and the other axle with cast-iron wheels. I would like to ask the committee if they consider that is safe enough.

MR. BARR: Mr. Chairman, I think the gentleman meant engine truck wheels, didn't he?

PROFESSOR HIBBARD: Yes.

MR. BARR: The only wheels that, in my opinion, have shown a weakness which we thought was liable to break the flange off when the flange was in good condition and everything perfect, are the leading pair of engine wheels in engine trucks. So far as my personal opinion is concerned, I would say that if the leading pair of engine truck wheels be steel-tired, you meet the peculiar requirements that call for a stronger flange than you can get on a cast-iron wheel, although we use the steel-tired wheels for both pair of wheels.

THE PRESIDENT: Are there any further remarks?

MR. SLATER: Mr. Chairman and Gentlemen, when the Committee on Steel Tires and Cast-Iron Wheels recommend that the engine truck wheels be steel, is not that a confession that they are safer?

THE PRESIDENT: Did you mean safer or better?

MR. SLATER: Well, both. As I understood, they were to be applied for safety.

THE PRESIDENT: Does the chairman wish to answer the question? He may if he will.

MR. BARR: Mr. Chairman, there are different kinds of safety. You may need a good, big, steel coiled spring of 1¼-inch diameter to run a 100,000-pound coal car, but you would not want to put that sort of thing under a buggy. Now the flange, of course, retains the wheel on the rail. I have never seen in my observations a good flange of a cast-iron wheel give way at any place except in engine truck service, and I do not believe anybody else ever has. That is the particular point of safety. So far as other points are concerned I believe that the cast-iron wheel will retain its integrity fully as well as, and possibly better, than a steel-tired wheel, except in that particular item of flange in guiding the front end of our heavy engines.

MR. GAINES: I would like to ask the committee from how much data they drew the conclusion that the cast-iron wheel service is cheaper than the steel tire.

MR. BARR: That is given in Statement No. 9, on page 19 of the report.

THE PRESIDENT: Does that answer your question, Mr. Gaines?

MR. GAINES: It answers my question. I would only like to remark that it is a pretty sweeping conclusion to be drawn from two roads only.

MR. SMALL: I would like to ask if the committee considered the effect on cast-iron wheels of the heavy capacity cars that are now coming into existence; that is, the effect on cast-iron wheels from long continuous braking, and possibly increased braking power that would be necessary to hold those cars.

MR. BARR: Mr. Chairman, that is a very important question. I had some experience in that direction while I was on the Pennsylvania road, but on the road with which I am now connected that consideration does not apply very forcibly, and unfortunately the three members of this committee are all on roads in which the question of grades is not a very important consideration; but it seems to me if there is to be a continuation of this work for the following year that we ought to have at least one member of the committee

who would represent that side of the question, and would be able to present facts on the actual breakage of wheels on those grades. I will say this, that so far as passenger cars are concerned, in running the heavy grades on the Pennsylvania road — and there are heavier ones than those — so far as my recollection serves me, we never had a broken cast-iron wheel in running those grades on passenger equipment. We had them on freight. On the St. Paul road we have never had a broken passenger car wheel that would derail a train arising from anything of that kind.

MR. ATKINSON: In looking over Statement No. 9, it does not appear to me that steel-tired wheels receive quite proper consideration. I have no prejudice either way at all. The value of the scrap steel-tired wheel is given as $5; the cost, new, $67.32; but it does not give the cost of renewing. What that scrap was I do not know; I presume it is in the report. I presume the fifth item, 11.98, is the cost per thousand miles run, in cents, after deducting from the first cost the scrap value in $67.32 — $5. What became of the wheel center, and the retaining ring? It should be only the tire and the cost of putting it on. I would like to get to what is the very best value for our roads and at the same time the safest, as probably we have the hardest service on the continent, so that safety is essentially the first point.

MR. LAWRENCE: I beg to say that the noon hour has arrived, when topical discussions are in order.

THE PRESIDENT: It is customary when a paper is under discussion, to conclude it. I think we are nearly at the end now.

MR. DELANO: One thing which I think confuses this entire subject in our minds is the fact that both in steel-tired wheels and in iron-chilled wheels there has been a very vast improvement in the last three or four years. The steel-tired wheels that were made up to, say, five years ago have given, in service, a good deal of trouble from breakage through the retaining-ring cavity groove. The improved methods of fastening the tires and the improved methods of casting the tire ingots have, I think, done away with this difficulty. In the same way with the iron-chilled wheels, there has been a great improvement in the material. The thermal test which has been introduced pretty generally has tended to that, and lately the question of the design of cast-iron wheels has been

taken up. The greater weight of the plate of the wheel has greatly added to its strength and its life.

MR. JOHN HICKEY: I would like to inquire if the committee considered the point of the proper weight of cast-iron wheels for the different capacity cars. As we are now getting very heavy cars, it is very interesting to know what this Association would name as a proper weight for wheels of different capacity cars. I refer to cast-iron wheels.

THE PRESIDENT: That was not considered, Mr. Hickey, the chairman of the committee says.

MR. HICKEY: Mr. President, if the committee is continued, would it not be well for it to report on that point?

THE PRESIDENT: That will be for the convention to say.

MR. HICKEY: If I am in order, I will move that the committee consider the suitable weight of wheels for different capacity cars.

MR. LAWRENCE: I second the motion.

MR. BARR: Mr. Chairman, I believe Mr. Hickey forgets that this is the Master Mechanics' Association.

MR. HICKEY: No, I do not; I know it is the Master Mechanics' Association.

MR. BARR: This is the relative merits of cast-iron and steel-tired wheels for locomotive and passenger car equipment. Freight car equipment is not included in this matter at all.

MR. GILLIS: I think the result which Mr. Hickey desires would be obtained by substituting the words, "different capacity tenders," instead of "different capacity cars."

THE PRESIDENT: How would that do, Mr. Hickey? Mr. Gillis has suggested that it be changed in this way: that instead of using the term freight car, that we say locomotive tenders. He says it will cover the same ground—the different weights of wheels for locomotive tenders.

MR. HICKEY: I will give way to that.

THE PRESIDENT: The committee, having that understanding, will consider it in that connection.

MR. HICKEY: The Master Mechanics have taken hold of it, and I think it is a fit subject for them to take up and know about. If we can not get it in under the head of cars, we can get it in under the head of tenders, and I will give way to that.

THE PRESIDENT: A motion has already been passed that the committee be continued, and the motion of Mr. Hickey is in order. The Chair entertains it. It is that the committee be instructed to consider the weights of wheels for the different weights of tenders. Does that include it all, Mr. Hickey, as I put it?

MR. HICKEY: Yes, sir.

THE PRESIDENT: All in favor please say "aye"——

MR. WHYTE: May I add to that motion, please, that it include also the distribution of the metal in the hub and plate?

THE PRESIDENT: If there is no objection to that, that will be accepted. All opposed, "no."

The motion was carried.

MR. MCCONNELL: I think that Mr. Barr's suggestion in the line of adding to the committee members of this Association who have had experience, and are having experience with engines on heavy grades, is a good one, and I would, therefore, move that two additional members be appointed on this committee, and that they be selected from roads having heavy grades.

The motion was carried.

MR. ATKINSON: Looking over Statement No. 9 further, I notice that the largest mileages were those made by the 30 and 28 inch cast-iron wheels. These are presumably engine truck wheels.

MR. BARR: They are marked so in the column next to the end.

MR. ATKINSON: That lowers the record considerably, and if that is correct, we shall make no mistake in using cast-iron wheels in engine trucks, although the committee recommends steel tires.

MR. BARR: Mr. Chairman, I can not understand several of the gentleman's conclusions on this point. He is now mixing the matter of safety with the matter of dollars and cents.

MR. ATKINSON: If there was a distinction between freight and passenger I could understand it. I do not wish to have any of us forced into the use of steel-tired wheels for freight locomotives against the interests of the road in dividends.

THE PRESIDENT: If there are no other remarks, gentlemen, the discussion of the subject will be closed.

MR. SINCLAIR: I move that the discussion be closed.

THE PRESIDENT: It is closed. We will take up the noon topics

now, and I will ask Mr. McConnell, the first vice-president, to kindly act as president during the noon hour.

Vice-President McConnell took the chair.

THE CHAIRMAN: Gentlemen, in view of the fact that we have lately had under discussion the question of the best methods of preventing trouble in boilers from water impurities, Subject No. 10 would come in very nicely at this time, and I will therefore ask Mr. Morris to open the discussion on that subject. Subject No. 10 is, "Can the ordinary marine salinometer be used to advantage in districts where alkali water has to be used in order to avoid excessive concentration and damage to fire box?"

Mr. W. S. Morris read the following discussion:

Mr. President and Gentlemen of the Convention:

The subject, "Can the ordinary marine salinometer be used to advantage in districts where alkali water has to be used, in order to avoid excessive concentration and damage to fire boxes?" assigned by your committee to me to open for discussion, came to hand at a date that would not admit of any great amount of research; but through the courtesy of the Newport News Shipbuilding and Dry Dock Company, I have obtained blue prints showing two salinometers, as applied to gunboat No. 7 and battleships 5, 6 and 7 (the Illinois, Kentucky and Kearsarge).

As shown in these prints, it will be observed the salinometer consists simply of a brass cylinder with a valve for regulating the flow of water into the cylinder and a device whereby the flow is made extremely quiet. When there is drawn from the boiler a sample of water of sufficient quantity to fill the pot, the valve is closed, and the hydrometer is then introduced into the cylinder. This hydrometer, of course, does nothing but indicate the specific gravity of the sample water, and by that the specific gravity of the water in the boiler.

The impurity of feed water has long been a serious problem for the railroad people in many sections of this country, and the many attempts intended to counteract its injurious effect upon the fire boxes and tubes have been of little or no avail. The only remedy we know so far has been to avoid the most injurious water, by selecting places along the line where the relatively best or purest water can be obtained, though this, often, is connected with a disadvantageous distribution of the water tanks. The determination of the quality of the water from the different places has not been successfully solved by other than chemical means, and it has been suggested that an instrument like a salinometer, in use in the marine service, should be used for this purpose. This instrument, however delicate, could not show the proportions of the several solutions, nor would it indicate the presence of any solution, either single or combined, of the same, or approximately the same, specific gravity of the water itself. The most injurious solutions are often of a low specific gravity, and the quantity is also proportionately small. I know of a case where the impurity is only 3½ grains to the gallon and the water is very injurious to the boiler, so

we avoid its use as much as possible. This impurity would be impossible to detect by mechanical means.

The temperature is another factor that must be taken into consideration; a few degrees more or less would introduce an error difficult to correct with the presence of the other combinations.

I have been requested to open this subject, and regret that with the researches I have been able to make as to the practicability of the use of a salinometer for determining the amount of impurity of alkali water, I can not present any recommendation for its adoption; but would be glad to hear what experience the members have had in this line.

MR. R. ATKINSON: Mr. Chairman, in connection with this subject I may say that it has been brought home to me through the failure of a fire-box sheet. A piece of the sheet was cut out and forwarded to me. The sheet was cracked about a foot. They could find no explanation for it. There was no mud in the boiler. There was not more than the thickness of a piece of paper of scale on the sheet, and it caused a good deal of talk. The only conclusion I could arrive at was that possibly the locomotive tender had been working in an outlying district, and concentration of the solids in the water might have caused it to become much heavier and more dense, and not being detected, on account of being clean, it allowed the water sheet to be damaged before any one was aware of it. I could find no other cause. Suppose a locomotive boiler containing 1,000 gallons runs over a division of 100 miles and is refilled, probably, six times in that distance; if the distilled water from it contains no solids, all the solids are left in the boiler, and it is concentrated up to sevenfold. It is thirteen times as concentrated when the sheet comes back, and if you have twenty grains at the commencement in your water, as you go it amounts to a considerable quantity. I do not know how to overcome the difficulty. The salinometer might assist us to some extent. On the other hand, since that time we have been using blow-off cocks, but they are used more or less indiscriminately, and if the salinometer were used by, say, the locomotive foreman, he would check up the change of the water in the boiler in time to avoid the destruction of the fire box.

MR. WILLIAM MCINTOSH: It occurs to me that an instrument of this kind might be used to advantage to test the various waters; say apply it to a locomotive and run it over the division under proper supervision, and ascertain the density of the various waters, and then issue instructions as to blowing out. That would avoid its becoming

too dense. I can not see that it could be applied in any other manner to prevent it.

MR. ANGUS SINCLAIR: I have had considerable experience with the use of the salinometer. It is merely a development of the hydrometer used to test the specific gravity of alcohol. It is used almost exclusively for finding out the density of water in boilers that use salt water as feed water. I was at sea for two years, and the practice was to test the water during each watch, take the specific gravity, and if it was high blow off a certain quantity of water to reduce the gravity. The instrument is not adapted for anything but that. It is not adapted for any purpose except for material that increases the specific gravity of the water very rapidly. It is of no use in trying to detect the quantity of lime salts or any salts you meet in land feed water, for the simple reason that they increase the specific gravity of the water very little. You would need as delicate an instrument as a hydrometer anyhow before you could do anything of that sort, and from my use of those two instruments I believe that it is utterly impracticable to use them for detecting the amount of impurities in feed water.

THE CHAIRMAN: Do any of the other members of the Association wish to make any remarks on this subject? If not, we will proceed to the discussion of Subject No. 5, to be opened by Mr. William McIntosh: "Is the use of fusible or soft plugs in the crown sheets of engines advisable?"

Mr. McIntosh read the following discussion:

During a somewhat extended residence in the Northwest, in what is known as a bad-water country, I can only recall less than half a dozen injured crown sheets resulting from low water. Coming east into a good water region I expected to find such cases unknown, but on the contrary they are quite common. In the West fusible plugs are not used, while here it is the universal practice. It would naturally seem that the fusible plug should prove a protection by giving timely warning of low water, or by extinguishing the fire altogether, but it appears to do neither, for owing to its dilatory performance the damage to crown sheet is accomplished before it blows out, or else its action is but partial and the volume of escaping steam not sufficient to affect the fire or attract attention. I exhibit here three plugs partially blown out, where the crown sheets were materially injured in each case. I therefore conclude that the fusible plug is not advisable inasmuch as it fails to afford the desired protection, and that it is mischievous because it might induce an engineer to take chances which he would not dare assume without it. There is no better protection for crown sheets than properly located water glass and gauge cocks, with an efficient engineer in charge who fully understands that he will be held responsible for all damage.

MR. ANGUS SINCLAIR: Mr. President, I hate being the stock

speaker of the Association, but I have had considerable experience with soft plugs. When I was an engine-driver in Europe they were used universally. They were considered to be a necessity, and in the lime district there was no end of trouble with them. If the water got low the soft plug would not blow out very often, and in other places where there was no lime it would be constantly melting by degrees until it blew out some day, and then the engineer would get suspended for a couple of weeks because his lead plug blew out. I consider them a most unreliable effort at safety. The Railway Master Mechanics' Association has been on record several times as saying that they were of no value whatever, and we would be safe enough were we to indorse the old sentiment today.

MR. H. A. GILLIS: Mr. President, I believe that some of the members of the Association have tried a method of fastening their flue sheets which is practically supplying them with a number of fusible plugs, while not fusible by any manner of means. They use a riveted stay alternately with a headed stay, the idea being that if the water gets off the crown sheet the riveted stay will give way ahead of the headed stay, and act exactly as a fusible plug, only more effectively. Instead of having one fusible plug you may have fifty, and the riveted stay giving way will sprinkle the fire and put it out at once. I know a number of superintendents of motive power who have applied stays in this way, and I think it would be interesting to know how many of them have had crown sheets blow down, and whether this method of application has been beneficial or not.

THE CHAIRMAN: Are there any further remarks to be made on this subject? I think the proceedings of the Association of several years ago will show that this subject was thoroughly discussed and a great deal of information was obtained from the members of the Association on the subject. I cannot give you the year, but my recollection is that at one of the meetings which I attended that subject was up.

MR. SINCLAIR: Mr. President, in my recollection the subject has been up twice, and probably it was up at other times also, but the conclusion always arrived at was that it was no means of increasing the safety of the boiler. Therefore, sir, I move that it is the sense of the American Railway Master Mechanics' Association that the use of fusible plugs in the crown sheets of locomotive fire boxes is not conducive to the prevention of the overheating of the crown sheet. (Seconded.)

THE CHAIRMAN: Gentlemen, you have heard the motion. Are you ready for the question?

MR. ATKINSON: I was going to say, Mr. Chairman, that for many years I have always had it instilled into me that a fusible plug was not a safety device, and there was a plug being passed around this morning which I should judge was a fair sample. For that reason, for twenty years past I have been a steady opponent of the use of fusible plugs. We have had some boilers explode, but in all cases except one the water has been low. In that case it was doubtful. If the water is low, nothing can possibly save the boiler that I am aware of except letting the crown sheet down as safely as you possibly can. For that reason, having seen crown sheets blow down which were supported by direct stays riveted over, and in other cases the riveted-over stays blew open and the crown sheet held on where the button-head stays were, I have made use of the alternate arrangement comprising the two. It is a very easy matter with a hot crown sheet to blow it off a riveted stay, but it is very difficult with a buttonhead stay. If all the stays are buttonhead stays and the crown holds, the shell is almost certain to give way, and that appears to me to be a result we wish to avoid more than anything else on account of the great destruction. I am at present using a combined system. I think, from the appearance of fire boxes giving way in the past, that we shall succeed in letting off the pressure without either tearing out the fire box or bursting the shell.

MR. A. E. MANCHESTER: My judgment is that there is but one way to keep crown sheets in proper shape on the fire box, and that is to keep water on top of them.

MR. MACKENZIE: I second that.

MR. MANCHESTER: I believe that fusible plugs are only a deception, and something for somebody to depend on when they have got into trouble, and say it didn't work; that the riveted stay is another deception, and that if you get heat enough for the riveted stay to go, the buttonhead stay is mighty poor protection.

THE CHAIRMAN: Mr. Manchester, will you pardon me a moment, please. The question to be discussed now is on the adoption of Mr. Sinclair's motion.

MR. MANCHESTER: All right, I fully agree with the previous utterances of the convention if they have been in the line of not using

fusible plug, that they are of no particular benefit. Neither do I believe the different methods of fastening the crown stays to act as fusible plugs, or, in other words, to blow up our boilers in detail, are of any particular advantage.

MR. ATKINSON: I had a case in point. The back end of a fire box was supported by stays hammered over, and the front end for about six rows with buttonheads. The front was five inches higher than the back, and held on. The back tore away until it came to the button-head stays, and stopped there. From that I deduced the idea that it would be better if we let the pressure off them quietly.

Mr. Sinclair's motion was then put and carried.

On motion of Mr. Quayle, the discussion was closed.

THE CHAIRMAN: We will now take up question No. 6: "What advantages are gained by the use of piston rods extended through the front cylinder heads?" The discussion to be opened by Mr. R. H. Soule.

MR. SOULE: Mr. President and Gentlemen,— This question of the benefits, if any, following the introduction of extended piston rods, or tail rods, as very often called, is one of those questions which are coming to the front as one of the natural consequences of the great increase in the size and power of locomotives. The diameter and stroke of cylinders having been increased greatly in recent years, and the boiler pressure as well, of course those combined influences increase the tendency of the piston to wear the cylinder from the time the arrangement first gets out of line. In canvassing this question among the members present, I find that there is very little fixed opinion on the subject among the railroad men, and no unanimity of opinion among the locomotive builders. I heard of one road, the New York Central, which has made it a rule in recent years that all cylinders nineteen inches or upward in diameter, shall have their piston rods carried through the front ends. I heard from a locomotive builder that in their own family they did not consider that it was necessary to apply the piston-rod extension unless the cylinder was twenty-eight inches in diameter and upward. So you see at once there are wide limits of opinion bearing on this question.

Then again, as regards the mechanism by which the piston-rod extension can be supported, and encased where it passes through the front end, there is no settled practice as yet. It seems to be very difficult to get a bushing or support more than, say, five inches in

The best device which I have seen is one in use on the Atchison, Topeka & Santa Fe road, in which they have a long bearing, similar to the one I have just mentioned, and just ahead of that they have a packing gland and metallic packing, packed with Jerome or any other used on the regular piston rods. One difficulty we find with ours, in which there is simply a brass bearing and a sleeve over the extended piston rod, is the matter of lubrication. We have on most of the engines a lubricating cup. I do not know that that will describe to you what I mean; but it is a cup the oil in which is displaced by condensed steam, the same as on a lubricator, except that there is no sight feed. It will hold possibly a quarter of a pint. But we find that the first time the locomotive throttle is closed the oil is all drawn out of this lubricator cup. With the device used by the Santa Fe they have a perfect means of lubrication, as much as you have on the piston rod at the back end of the piston. Under the circumstances under which we operate, I believe the extended piston rod will prove a valuable feature, and with the packing on the extended piston rod as well as on the piston rod proper, I see no reason why the wear can not be reduced both on the extended rod and on the bearing.

MR. FRANK SLATER: Mr. President and gentlemen,—I have had some experience with the extended piston rod, and I fail to find any value in it whatever. My opinion of the matter was that it was applied to prevent the wear of the cylinder, but after looking further into the matter I find that a cylinder does not wear on the bottom; nine-tenths of the cylinders wear on the top, and why should we apply something to hold them up when there is no wear there? It adds cost to the first construction, and the piston rod wears more on account of the lack of lubrication. If you apply a metallic packing, as suggested by Mr. Quereau, you add just one more place for a leak, and we all know that it is a very difficult matter to keep piston rods from leaking with metallic packing or otherwise.

MR. F. F. GAINES: The gentleman just on the floor has said exactly what I wished to say. I do not see any necessity for it. We have engines on our road running five or six years with a 30-inch cylinder, and it has no support whatever, and I do not think that we have had any appreciable wear in that cylinder over any other.

MR. SOULE: I would like to say something which I meant to incorporate in my opening remarks, but forgot to do so; that is,

that one of the legitimate questions in connection with this problem of extended piston rods is whether the increased clearance which necessarily follows their use is not detrimental to the economy of the engine. Of course we take it for granted that the extended piston rods are operating in closed tubes or pockets attached to the front cylinder head, although it is entirely possible to make an arrangement by which the extension shall pass through a stuffing box; but under present conditions the usual practice is to use the pockets for the rod to work in, and that necessarily increases the clearance at the front end of the cylinder. I have no information whatever bearing on that point, but it is doubtless a legitimate question whether that increased clearance would not impair the efficiency of the locomotive.

MR. WILLIAM MCINTOSH: I would like to ask the gentleman who spoke before Mr. Soule what kind of piston packing he used?

MR. GAINES: We used the regular United States metallic packing.

MR. MCINTOSH: Piston packing?

MR. GAINES: It is the regular snap ring, solid-head piston.

MR. J. COCKFIELD: I have had some experience by the use of the extension piston rods, in an engine 18 by 24 inch cylinder, ten-wheel, carrying 170 pounds of steam, and having the Allen-Richardson valve. This engine made 42,000 miles with this device, when we found it necessary to remove the packing rings. We continued the engine in service until she made 93,892 miles. When we calipered the wear of the cylinders we found it measured $\frac{3}{64}$ of an inch. The reason why we tried this device was on account of having so much trouble with the wear of the cylinder in this particular end. It demonstrated to my mind that this device was beneficial. This extension was covered with asbestos and jacketing to prevent condensation, and we had a bearing on the rod of four inches brass bushing secured permanently. The means of lubrication was from the cylinder in the usual method. After the engine left the division I have not any record as to how long this continued in service, but from the experience I have had with this one, I find that it has been very satisfactory indeed.

THE CHAIRMAN: Inasmuch as Mr. Marshall is not here, it has been suggested that Topics 6 and 7 be combined and discussed at the same time. They both have a bearing on the same subject.

Topic No. 7 is: "When extended piston rods are not used, which type of piston head is the cheapest, cylinder wear considered — the solid head or one with bull ring and follower?"

MR. DAVID BROWN: Mr. President, I do not think it is necessary to have the extended rod on an ordinary sized cylinder. As Mr. Soule said when he opened the subject, one road had it on a 19-inch— had that for a basis. That, I think, is a little small. I think we could go beyond that. We had an engine with a 24-inch cylinder and solid head, with a lining of block tin around the head. After awhile that wore away, and the crosshead began to show trouble. The crosshead also had block tin on top and bottom of the wearing surfaces between the guides, the front end of the crosshead would wear on the bottom, the back end would wear on the top, and whenever you went by the engine after she had run a little while it looked ridiculous. It looked as if the guides were out of line. The guides were not out of line; the piston had worn the bottom, and of course the crosshead followed on with it. We took the crosshead out occasionally and relined it, and put it in again in good condition, and we would turn the piston around and let the piston wear on the other side of it; but the same trouble would take place again. Then we would take the piston out and reline that all around and go through the same performance. Finally we decided to put the tail end on, or the extension rod. After we did that there was no further trouble. Consequently, we demonstrated that on a 24-inch cylinder an extension rod was a benefit. Now, if it was a low pressure cylinder, we could afford to put a gland on the front of the cylinder head, and it would last quite a while without renewing. We did not go to any expense of making a covering for it, any more than a piece of gas pipe, just to slip over the gland and prevent any dirt from getting on it. We had a bearing there of about eight inches, and kept it up very well. Now, with regard to the heads, it shows that the solid head on some roads, I won't say all roads, but on some roads where the grades are long, will wear on the bottom — I am speaking now as regards Subject No. 6 — and if we have some means of regulating the piston by bringing it up central, I think that also is a benefit.

MR. A. L. HUMPHREY: Mr. Chairman, so far as the extended piston rods on locomotives are concerned on engines that drift a great deal, I think that is beyond the experimental stage. So far as it

applies to our road, I know that with large engines, 20 and 21 inch cylinders, where they drift oftentimes a hundred miles at a stretch, it is absolutely necessary to have them in order to keep the cylinders from wearing. We have had locomotives, especially some 21 and 26 inch locomotives, in which it was impossible to run the cylinders more than six or eight months, regardless of the amount of lubrication that we used, without boring the cylinders. After applying the extended piston rod and having a 10-inch bearing made of the hardest bronze that we could get, I calipered an engine cylinder at one time after it had been running for thirteen months and the cylinder did not show quite a $\frac{1}{32}$ of an inch wear. We had been compelled to turn cylinders in six months before this was applied. That extension is put on to keep your piston central with the cylinder, and if the gentleman on the other side is bothered with cylinders cutting in the top, why will not this extension answer the same purpose in keeping the piston in the center of your cylinder and keeping it from cutting the top as well as the bottom? That is something I can not understand. I believe the time is rapidly approaching when all engines having large cylinders will have extended piston rods. I am inclined to think that the stuffing-box principle is a good one for all. We are not troubled with lubrication. At 180-pounds pressure, we simply use the lubrication in the cylinder, nothing else, and so far have not experienced any trouble, except, of course, we turn the bushings quite often and keep them as nearly central as possible. Probably every sixty days we turn the bushings.

MR. ROBERT QUAYLE: With reference to the wear of cylinders on the top, that used to be considerable of a conundrum to me, and it may be yet. But I have attributed it to this, that the oil being of greater specific gravity than the steel, naturally falls on the bottom, and that you have a constant lubrication there which you do not have on the top, and when your steam is admitted into the cylinder your rings are expanded. The holding of your piston to the center would perhaps not prevent that — it might in some degree, but I think not altogether; the rings would be expanded, and they would naturally do their cutting the same as if there was no holding arrangement there. I may not be correct in my conclusion, but it will appeal to you, I think, as perhaps being somewhat reasonable.

MR. F. F. GAINES: We had a similar experience to what Mr. Quayle has stated. We have engines on the road where the packing

rings will wear out, nothing on top of the cylinder, and yet the tool marks will not be off the piston itself, which only goes to prove that it is a matter of want of lubrication there.

MR. ATKINSON: There is more than one cause at work, because in some that I have personally inspected for several years past there is a distinct mark at the piston, also at the front end of the cylinder on the top, none at the back; so that it cannot be want of lubrication. The distance the piston traveled is distinctly marked on the cylinder.

THE CHAIRMAN: Mr. Sague, can we hear from you on that subject?

MR. J. E. SAGUE: We have used extended piston rods to a very great extent, especially on compound locomotives. Our first effort in that direction was with brass bushing five inches in length. That did not seem to be enough. The wear of the bushing was excessive. We now have extended the length of the bushing to nine and ten inches. I suppose we are the builders Mr. Soule refers to as putting an auxiliary triple sight feed lubricator in the cab where the extended piston rod is used, but I would like to say that we do not feel by any means that that is an absolute necessity. In fact we build more engines with extended piston rods on which that auxiliary lubricator is not used than engines on which it is used. We think the auxiliary lubricator may be of advantage, and it is of special advantage where engines do a great deal of drifting. We provide extended piston rods for all compound locomotives, and apply the auxiliary lubricators to such engines as do a great deal of drifting. Our experience has been most satisfactory with extended piston rods, so much so that if we were asked to guarantee the wear of a cylinder without boring, say for two or three years, we would want to insist that extended piston rods be used. My personal impression is that extended piston rods are a good thing with 19-inch cylinders and over, and possibly with smaller than 19-inch cylinders.

MR WILLIAM HASSMAN: There is one feature of this discussion which appears to be lost sight of and on which I would like to get some information. I have not had experience enough with the extended rod to gain that information myself. The breakage of piston rods back of the crosshead has been a very prolific source of trouble, and the extended rod that I had experience with was put on with a view of overcoming that. I should like to hear from somebody who can give us some information on that point.

MR. F. A. DELANO: Mr. Chairman, if what is desired is to increase the bearing surface, it seems to me that we can do it in the piston itself rather than by putting an extension rod on, and for the information of these members I would call their attention to the Pennsylvania designs of engines H 5 and H 6 which were illustrated in the last number of the *American Engineer*, the June number. The Pennsylvania, in the case of that engine, put a flange on the lower portion of the piston forward and back and extending not quite halfway around—about 120 degrees around the circle, one-third of the way around the circle to carry that piston. Why does not that accomplish the same purpose for a smaller additional weight than any other way?

THE CHAIRMAN: Gentlemen, are there any further remarks on this subject? If not, we will close the discussion. Before proceeding with the next subject, with your consent, we would like to hear from Mr. Barr as chairman of the Committee on Resolutions.

MR. J. N. BARR: Mr. Chairman, I have the following to present:

WHEREAS, Mr. John W. Cloud is about to retire from the position of Secretary of the American Railway Master Mechanics' Association, on account of taking up a new business connection which will require him to reside abroad; therefore be it

Resolved, That the great value of the services he has rendered as Secretary of this Association is acknowledged by common consent, and that we appreciate not only the skill, fidelity and zeal which he has displayed in the discharge of his duties, but also his uniform courtesy toward those with whom he has had to deal.

Resolved, That the good will and best wishes of the Association and its members will follow him throughout his future career.

(Applause.)

THE CHAIRMAN: Gentlemen, what is your pleasure with the resolutions?

MR. DELANO: I move that the resolutions be adopted by a standing vote. (Seconded.)

THE CHAIRMAN: Gentlemen, it has been moved and seconded that the resolutions be adopted by a standing vote. All in favor of that motion please rise.

All present rose.

THE CHAIRMAN: It is a unanimous vote. (Applause.) Mr. Cloud, can we hear from you?

MR. CLOUD: Gentlemen, I can only say that I thoroughly appreciate this as coming from you, and the thought of it, when I

do not have my friends and acquaintances around me, will help in some measure no doubt to compensate for their absence. As I have enjoyed very much serving you as Secretary, and have endeavored to do what ought to be done as such, I have learned to know you better, and I am very sorry that circumstances are such as will require me to be separated for some years from most of my friends in this country, and I believe that I will miss my business friends and connections more than I can express. It will be always a pleasant thought for me to remember, however, that you were so kind as to express your views and your feelings in these graceful resolutions. I thank you one and all. (Applause.)

THE CHAIRMAN: Gentlemen, as it is now one o'clock, discussion of the topical subjects will be closed and we will proceed with the other business of the convention. I have the report of the auditing committee before me, which is as follows:

To the President and Members of the
American Railway Master Mechanics' Association:

We have examined the reports and accounts of the Secretary and Treasurer of this Association for the past year and find the same correct.

Respectfully submitted.

L. R. POMEROY,
A. F. STEWART,
A. E. MITCHELL,
Auditing Committee.

Gentlemen, what is your pleasure with the report?

MR. MANCHESTER: I move that it be accepted and the committee discharged.

THE CHAIRMAN: There is a communication here, gentlemen, from the Philadelphia Commercial Museum, which says:

I wish to call your attention to the National Export Exposition, to be held in Philadelphia on the 14th of September of this year, and also to the International Commercial Congress, which will convene on the 10th of October. I write to ask that you kindly extend an urgent invitation to the members of your important Association to be present at some time during the Exposition and the Congress. Every courtesy will be extended to your members that will tend to make the Exposition of interest to you.

Very respectfully,

W. P. WILSON,
Director.

Gentlemen, what is your pleasure with the communication?

MR. MCINTOSH: I move that it be received and placed on file and the Secretary instructed to acknowledge its receipt.

The motion was carried.

President Quayle here took the Chair and said: The time has come, gentlemen, to resume our discussion of papers. Before we take that up, I want to emphasize, if I may again, the announcement made by the First Vice-President a few minutes ago, to the end that you be present, as many of you as can, when the photograph is to be taken. I am sure that I would like to have one of those photographs myself and put it up in my office and look sometimes during the year at the faces of those I have met here at the convention, and remember them kindly.

The next subject is No. 4: "Advantages of the Ton-Mile Basis for Motive Power Statistics." Mr. Small, if he is present, will come forward and present this report.

Mr. H. J. Small presented the following report:

REPORT OF COMMITTEE ON ADVANTAGES OF THE TON-MILE BASIS FOR MOTIVE POWER STATISTICS.

To the President and Members of the American Railway Master Mechanics' Association:

Your committee, appointed to investigate and report on the above subject, has endeavored to obtain from the individual membership an expression of opinion as to the relative value of the various methods now employed by the railroads of this country in presenting motive power statistics, and find that, while very few of the railroad systems have adopted the ton-mile basis, they are almost unanimous in expressing the belief that the ton-mile basis is the most desirable unit to use for the purpose, although many are in doubt as to the practicability of presenting statistics that would be entirely fair for comparison under all conditions.

The following argument on the advantages of the ton-mile basis, made by Mr. Sherman, of this committee, clearly illustrates the desirability of using the ton-mile unit:

"There are so many varying conditions, as the quality of coal, scale of wages, types of engines, water, grades, average speeds and the business to be done, that we believe it is unwise to attempt to compare the motive-power statistics of even different divisions of the same system, much less the different systems, except in the most general way. This conclusion is based on the assumption that the statistics will be compared with a view to bettering the records. We are fully persuaded that it is not only more just, but a better policy, and will secure much better results to compare the records of each division, or system, with those made by the same division, or system, during the same period of previous years. An illustration will, perhaps, help to make the reasons more apparent:

"Division A had the best coal on a certain system and made the best coal record, almost as a matter of necessity, for this reason it was very difficult to get the men on this division to make an effort to effect a saving in fuel. This was a perfectly

natural result, because they were entirely satisfied when comparing their results with those of the other divisions; but when a comparison of their record for one year showed they were using more coal than the previous year, their interests and ambitions were at once aroused and a decided improvement made.

In the same system was Division B, which had the poorest coal and water as well as the heaviest grades. Naturally their coal record was the poorest on the system, and it was extremely difficult to get them to make any systematic effort to improve it, because they were so far behind all the other divisions they felt there was little use. As soon as the record for January, 1898, was compared with that made by the same division in January, 1897, and it was discovered that a considerably better record had been made in 1898, all interested were stimulated to make special efforts, which resulted in saving a number of thousands of dollars.

So long as we rely on a comparison of records made by other divisions or systems, just so long will innumerable excuses be made concerning poor coal, bad water, light or heavy engines, grades, time, and a host of other unfavorable conditions which, whether reasonable or unreasonable, will be used by both officials and employes as good excuses for poor records and failure to improve. If the standard of comparison for each division is the previous record made by that division, the excuses which might be valid when comparison is made with some other division have little or no weight, because the conditions on each division are practically the same one year and another; or if there are noticeable changes, a proper allowance can be much more easily made, as they are well known to the men and officers on that division. For these reasons we believe it unwise to attempt to secure a uniform basis for motive-power statistics with a view of making the records of all railroads comparable. We believe, however, that these reasons do not hold good in trying to secure the best basis for motive-power statistics.

We believe that there will be no dissent to the proposition that statistics accurately compiled and carefully studied are necessary for the successful operation of any railroad department; and we believe we are justified in the statement that this is especially true of the motive-power department, because of the large amount of money spent in machinery, wages and supplies. If the statistics we use in determining the cost of operations to devise cheaper methods and determine costs are liable to lead to inaccurate conclusions, the matter is of great importance and should receive careful consideration.

It seems to us evident that the basis for engine-service statistics should be the work performed by our locomotives. This work includes the elements of time, distance and weight moved, and a perfect basis for motive-power statistics should include all three of these; under service conditions, however, it is practically impossible to include all three elements, except at a prohibitive expense.

If our statistics are kept under the heads of passenger, freight and switching, and the various runs classified under these heads, the variation due to the influence of time or speed will be very greatly reduced, as with this subdivision of the statistics, passenger records will be naturally compared with other passenger records, and freight with freight, and switching with switching. We believe that if this is done we can afford to neglect the element of time in the basis for our statistics, as such a classification of statistics will reduce to a comparatively small amount the influence of this element.

The basis of the cost per mile is now almost universally used, but it seems to us evident that the statistics derived from this basis are misleading and inaccurate, because based solely on the element of distance, neglecting the very important element of the weight moved.

The loaded-car-mile basis, which is sometimes used, roughly approximates accuracy as far as distance and the weight moved are concerned, and we believe, is much more accurate than the mile basis, but is far from ideal because of a great difference in the weights and capacities of cars; gives the same value to a load of straw hats and one of pig lead, and arbitrarily fixes the ratio between the weight of empties and loads. These objections have especial force when a railroad has both standard and narrow gauge equipment.

We believe that these objections do not apply to the ton-mile as a basis for motive-power statistics. It is true that the ton-mileage, as obtained under the usual conditions, is not absolutely accurate; that it does not take into account the difference in the power required to haul a ton of train in empty and loaded cars; that it is difficult, if not impossible, to obtain accurate ton-mileage records of local and stock trains. In short, the ton-mileage records as they are obtained under service conditions are far from perfect, but we believe what follows will show this basis to be considerably more accurate than the mileage basis, and what is much more important, tends to encourage more economical methods of operating, while the reverse is true with statistics based on the engine-mile.

It has been objected that the ton-mile basis does not take into account the comparative resistance due to grades and speed, to the difference in the power required to haul a given weight of empty cars and loaded. We believe these objections apply with equal force to any other basis which may be used.

The statistics which follow are taken from the actual records of a Western trunk line. That they cover only a short period of time is due to the fact that the examples used were originally prepared for reports made in the ordinary course of business, and lack of necessary time has prevented the compiling of records covering a longer period. We believe, however, the conclusions drawn would not have been different had longer periods been used. They are inserted as illustrations which may make the point discussed clearer than a lengthy discussion.

It has been stated that the ton-mile is a more accurate basis for engine statistics than the engine-mile because it is a more correct measure for the work done. An illustration will make this clear.

TABLE 1.

March.....	1896	1897	Increase per cent.
Average miles per engine	2,282	2,289	$\frac{8}{10}$
" ton-miles per engine.....	782,213	972,486	24

On the engine-mile basis the above statistics show that the engines did practically the same work in both 1896 and 1897, while those obtained from the ton-mile figures show an average increase of 24 per cent. There can be no doubt that the

ton-mileage is a much more accurate approximation of the work done than the figures giving the average mileage.

COST OF LOCOMOTIVE SERVICE.

FUEL.— Railroad men quite generally rely on the number of miles made to the ton of coal in determining their economy in the use of fuel. This basis is of comparatively little value, and may easily and naturally lead to wrong conclusions, because the fuel used is not compared with the work done. In Table 2 the branch line is a mountain road with numerous grades, maximum 3 per cent, and heavy frequent curves, maximum 16 degrees, while that part east and west of division is considerably easier to operate. The three districts named cover the whole division:

TABLE 2.

DIVISION D, JANUARY, 1896.

PASSENGER SERVICE.

	Miles to ton of coal.		Coal per 100 ton-miles.	
	1	2	3	4
	Lbs.	Per cent.	Lbs.	Per cent.
Division point east	26.3	122	34.20	103
Division point west	32.1	100	33.09	100
Branch line	20.2	159	53.86	163
Whole division, average	27.1	100	36.08	132
FREIGHT SERVICE.				
Division point east	16.6	100	20.79	100
Division point west	16.2	102	30.15	145
Branch line	14.8	112	67.93	327
Whole division, average	16.1	168	27.40	100

Columns 2 and 4 may be considered as showing the number of pounds of coal used in doing the same work as determined by the records shown in columns 1 and 3 respectively. Under Passenger Service, the first three lines in the same column are compared with one another, the best record being 100. The same is true under Freight Service. The fourth line under Passenger Service is compared with the same line under Freight Service.

If, under Passenger Service, we compare the performance of engine crews east of division point with those west, on the basis of miles made to the ton of coal, we find there is a difference of 22 per cent in favor of those running west. There were but two main line passenger trains on Division D, one going west and one east, so that it would appear certain, to anyone looking over the performance sheet, that the passenger crews east of division point were doing poor work. Anyone specially familiar with the service on this division would know that a car was taken off the west-bound train and added to the east-bound train, both at A and B, and would therefore know that the enginemen east of division point were pulling more cars than those west, and be justified in concluding that the men east could not be expected to make as many miles to the ton of coal as those west of that point. It would, how-

ever, be next to impossible for anyone to say just how much difference there should be. If this is true, when one is familiar with a division, it can be readily seen that a performance sheet based on the mile gives little reliable information. If a comparison is based on the ton-mile, column 4, it will be seen there is a difference of but 3 per cent, east and west of division point; also that the ton-mile takes into the account the extra work made necessary by the heavier trains, and that the crews east were doing about as economical work as those west.

Consider the records made in Freight Service. An inspection of the miles made to the ton of coal on the branch line, in comparison with the main line east of division point, would naturally lead to the conclusion that it is costing only 12 per cent more for coal on the branch line. This is found to be very far from correct when the figures based on the ton-mile are used, as they show the cost on the branch line was more than three times that on the main line, and agrees with the common-sense conclusion that the expense for fuel is very much greater on a mountain road than on a comparatively level line, which would not be guessed from the usual statistics based on the cost per mile.

It is quite commonly taken for granted that a passenger engineer will make a better coal record than one in freight service, because the former makes more miles to the ton of coal. An inspection of Table 2 bears this out, showing that the freight men made a record 68 per cent poorer than those in passenger service, when judged by the number of miles made to the ton of coal. If, however, we compare the records made in the two services on the ton-mile basis, which has been shown to be a more nearly correct measure of the work done, we find the freight crews used coal 32 per cent more economically than the crews in passenger service; a showing varying 100 per cent from that made when the figures are based on the mile.

It seems evident from the preceding that the mile basis for fuel statistics is inaccurate and therefore misleading. This having been admitted, it follows that efforts directed toward intelligently improving our fuel records cannot accomplish the best results so long as this basis is used. It seems equally evident that the use of the ton-mile basis, because it is a much more nearly accurate measure of the work done, will be a decided improvement and accomplish more lasting results.

So long as the engine-mile is the basis of comparison, any considerable increase in the train load will decrease the number of miles made to the ton of coal, and increase the cost of coal per mile, other conditions remaining the same. As a result there is a strong temptation for enginemen and master mechanics, and possibly others, to so handle matters that their records will show at least as well as in the past. In other words, the engine-mile basis presents seemingly good arguments for light loading and inefficient work. If necessary it can be easily shown that when the ton-mile basis is used, the heavier the load, within reasonable limits, the less the coal used per ton-mile, and for this reason the ton-mile basis is a strong argument for all interested to co-operate to the end that the engines shall be loaded to their maximum capacity, service and weather conditions considered. The matter was aptly summed up by a master mechanic, who said: "When we were operating under the engine-mile system I was glad to see light engines going over my division, because they made my showing better; but now, under the ton-mile system, I dislike very much to see anything of the kind, because it hurts my record."

An experience of nearly three years with a tonnage rating for engines and

enginemen's performance sheet, showing their coal records based on the ton-mile, has convinced us that enginemen soon discover that the greater the tonnage they haul the better their fuel records, and that this is an important factor in fuel economy and reducing operating expenses. That the engine-mile basis has an opposite effect, we are quite sure those who have studied the matter will admit.

We believe we are not far from the truth in saying that the foregoing tables and discussion warrant the statement, that the use of the engine-mile as a basis of fuel comparison, naturally, and almost inevitably, leads to erroneous conclusions, and has a strong tendency to foster uneconomical methods of operating, while statistics based on the ton-mile are much less liable to mislead and encourage economy.

REPAIRS.— It would seem that the same line of reasoning which has been applied in comparing the merits of the engine mile and ton-mile in the case of fuel, should have equal force when considering the proper basis with which to determine the cost of locomotive repairs, and lead to the same conclusion. If an engine goes over the road light, it is credited with as many miles as though it handled a maximum load, but there can be little chance for argument that in the former case the wear on the engine and the chances of a breakdown are a minimum, while when worked to its capacity they are the greatest.

It seems self-evident that the cost of engine repairs per mile will be least when the engines do the least work, and it can be readily shown that the cost per ton-mile will be least when the engines are worked to their full economical capacity. Therefore, the ton-mile basis, when used in determining the cost of repairs as well as fuel, places a premium on heavy trains, thereby fostering economical operating methods.

Your attention is invited to Table 3, in which is made a comparison of the cost of engine repairs on engine-mile and ton-mile basis:

TABLE 3.

March.....	1896.	1897.	Increase per cent.	Decrease per cent.
Average miles per engine.....	2,282	2,289	$\frac{3}{10}$	.....
Average ton-miles per engine	782,213	972,486	24	.....
Repairs per engine-mile.....	4.48	5.25	17	.....
Repairs per 1,000 ton-miles.....	13.70	13.78	.....	1

The fact that, while the average number of miles per engine was the same for both years, the work done per engine, as measured by the average ton-miles, was 24 per cent greater in 1897, will account for the fact that the cost of repairs per mile run was 17 per cent greater in 1897. Had there been no ton-mile statistics, it would have been exceedingly difficult to have escaped drawing the conclusion that the cost of repairs showed an unwarranted increase in 1897, because, with practically the same average mileage in both years, the cost per mile increased 17 per cent. But when the cost is compared with the work done, as measured by the ton-mile, we discover that the cost of repairs was slightly reduced in the latter year

WAGES.— At first sight it would appear that there is no good reason for determining the cost of wages on the ton-mile basis, but we believe further consideration

will show the contrary. As the cost of wages is now shown, so much per mile, there is no inducement to reduce the cost of this item per ton-mile of freight, because the item of wages, on the mile basis, will be the same on a division which may average five cars per train as on one where the average is five times this. On the other hand, if the wages are compared on the ton-mile basis, it is evident there is a strong inducement to reduce the cost of wages per ton by increasing the tonnage hauled.

OTHER ITEMS.— If the arguments presented are considered sound, it would seem to be wise to use ton-mile as the unit of comparison for fuel, repairs and wages, or over 95 per cent of the total cost of locomotive service. With this large percentage on the ton-mile basis, it would seem proper to use it as the basis for the total cost, and all the items. The fact that a railroad has ton-miles to sell, and not engine-miles, seems to me sufficient reason for keeping the cost of locomotive service on the same basis, so that a direct comparison of the selling and cost prices of their commodity can easily be made. It should not be inferred from this that we would advocate doing away with a statement on the engine-mile basis, showing the oil records made by individual engineers, for we believe this important.

Tables 4 and 5 afford an opportunity for comparing all the items making up the total cost of engine service on both the engine-mile and ton-mile basis, for the month of March, 1896 and 1897:

TABLE 4.

COST OF ENGINE SERVICE IN CENTS PER MILE.

	1896.	1897.	Increase. Per cent.	Decrease. Per cent.
Miscellaneous and small stores	.63	.68	8	
Oil, tallow, and waste	.21	.27	29	
Fuel	6.82	7.34	8	
Wages	7.37	6.72		9
Repairs	4.48	5.25	17	
Total	19.51	20.46	5	
Average miles per engine	2,282	2,280	1-10	

TABLE 5.

COST OF ENGINE SERVICE IN CENTS PER 100 TON-MILES.

	1896.	1897.	Increase. Per cent.	Decrease. Per cent.
[illegible]	1.30	1.22		6
[illegible]	.23	.27	2	
[illegible]	11.33	11.52		8
[illegible]	13.23	13.31		22
[illegible]	13.30	13.28		1
[illegible]	39.39	39.48		12
[illegible]	2,852,853	2,854,280	24	

[illegible] the advantage of comparing the [illegible] as a basis of intelligent comparison.

and the great advantage gained by use of the ton-mile unit in freight service, there is a strong tendency to question the advisability of the ton-mile basis in passenger work and switch service. There is no difficulty in keeping ton-mileage for passenger trains; in fact, it was introduced on one large railroad system in this country, and abandoned because they did not consider the results of much interest, as the superintendent or master mechanic of a division has no control over the size of his passenger trains, the weight being determined by competitive and traffic conditions. It is known that the speeds at which they run are wasteful, but they are out of control of the division officials and largely of the managing officers.

Another point discussed in the foregoing is the advisability or the utility of a comparison of locomotive statistics as between one railroad system with another, or between divisions of the same system. It is undoubtedly true that it would be difficult to produce a form for presenting locomotive statistics that would show an entirely fair comparison as between one system with another, or one division with another. However, many members have suggested to the committee, that inasmuch as general managers and superintendents of motive power insist upon having some method of making comparisons of one system with another, or one division with another, that would show so far as possible the relative conditions of road, your committee has introduced into this report a suggestion for such a statement.

Your committee is of the opinion that the present form of locomotive performance sheet, based wholly on the locomotive-mile unit and sent out generally over the country for purposes of general comparison between railroads, is misleading and unsatisfactory; and while it is almost unanimously conceded that the ton-mile unit for freight locomotive statistics is preferable, even this is unsatisfactory, as the expense of a ton hauled one mile over a mountainous road cannot be compared with that of a ton hauled one mile on a level road. Again, a road with few grades, good water and cheap fuel can make a much better showing in operating locomotives than another road with heavy grades, high-priced fuel and bad water.

The theoretical ideal system, perhaps, was that introduced by Mr. F. W. Johnstone, Superintendent Motive Power of the Mexican Central Railway, and in use on that road from 1884 to 1896. His system reduced all work done by locomotives to the unit of 100-gross tons hauled one mile over a straight and level track, the road being reduced to the equivalent of a straight and level track; his formula for this system is as follows.

"Let 100 gross tons hauled one mile over a straight and level track (at so low a rate of speed that the resistance due to speed will be considered zero) be taken as the unit of work performed, and as the resistance per gross ton hauled upon a straight and level track at a very low speed is six pounds, the resistance per gross ton on any grade and at a given speed in miles per hour should be divided by six, and the result must be multiplied into the length of the grade to ascertain the equivalent length of level track. If curves are not compensated, one-half pound per degree of curvature should be added to resistance due to grade, speed and rolling friction, before dividing by six."

It is evident that for different speeds per hour the total resistance will vary, and the equivalent straight and level track will likewise vary, therefore it is necessary to figure out these distances separately for trains running on different schedules of speed, and for convenience of computation, tables were prepared to show the total resistance

per gross ton on various grades (curves compensated) for trains running at various speeds.

While with this system we could compare the performance of light locomotives on a level section of country with that of heavy locomotives in a mountainous section, it has been objected to on account of the clerical expense involved.

Your committee, after a study of the various methods of compiling and presenting locomotive statistics, are of the opinion that greater uniformity of practice is necessary, without which no satisfactory results can be obtained, also that the use of both the ton-mile and the locomotive-mile unit are necessary to properly exhibit all locomotive performance, the former for freight service and the latter for passenger, switch, and work service, and we have endeavored to present in the accompanying form those features which seem to present in the most precise form the information required by all. This form provides for a summary of performance and expense for comparison between divisions of a system, or one system with another, as it seems clear that the requirements of the different roads in making up individual performance of locomotives are of more importance locally that they could be as a matter of comparison with other roads. The following explanation of the proposed form is presented:

Column.

1. MILES OF ROAD OPERATED:
   Main and branch lines, including double track, but neither sidings nor spur tracks.

2. TOTAL LOCOMOTIVE-MILEAGE:
   The custom varies considerably in this particular; we believe this item should cover the actual mileage between terminals of locomotives in passenger, freight, or mixed trains, including mileage of helping and light locomotives in such service, with no allowance for switching. Mileage of locomotives in mixed trains to be divided in proportion of ¾ to freight service; ¼ to passenger service.
   Switch locomotives to be allowed 6 miles for each hour run; work locomotives to be allowed 8 miles for each hour run.

3. TOTAL TON-MILEAGE (in thousands for convenience) IN REVENUE FREIGHT:
   This represents the total net ton-miles of revenue freight.

4. TOTAL TON MILEAGE (in thousands for convenience), COVERING GROSS WEIGHT ON TRAIN:
   Covers the net weight of revenue freight plus the weight of train, which would include weight of locomotive, tender and the caboose.

5. TONS OF COAL CONSUMED (Tons of 2,000 pounds):
   This should include all fuel consumed by locomotives; coal, wood, fuel oil, and kindling, all reduced to tons of coal by assuming a certain number of cords of wood equivalent to a ton of coal, and a certain number of gallons of fuel oil equivalent to a ton of coal.

   In figuring the PERFORMANCE OF LOCOMOTIVES on basis of locomotive-miles run, the following has been selected as answering the require-

ments of the majority. All statistics on ton-mile basis to apply to freight service only; all other service on locomotive-mile basis:

6. LOCOMOTIVE-MILES RUN PER TON OF COAL:
   This solely for the purpose of comparing with other roads, although we do not consider that the information given is of much value.

7. LOCOMOTIVE-MILES RUN PER PINT OF LUBRICATING OIL:
   This to include all oil, tallow and grease used in lubricating locomotives and tenders; 8 pounds of grease or tallow assumed equal to one gallon of oil.

8. LOCOMOTIVE-MILES RUN PER POUND OF WASTE:
   This to cover all waste used in packing boxes of locomotive and tender, or delivered to enginemen, for other use on locomotive, and waste used for wiping.

9. GROSS WEIGHT OF TRAIN IN TONS:
   This to indicate the average weight of the freight train hauled.

10. GROSS TON-MILES PER POUND OF COAL:
    This, to us, seems the fairest manner of presenting the results of economy in use of fuel.

11. DIVISION.

12. REPAIRS:
    This should cover the total cost of all items of expense in connection with the maintenance of locomotives, including repairs, rebuilding, renewals and cost of new locomotives to replace those destroyed or worn-out; when such expense is incurred in railroad shops this should include the usual per cent added to cost for shop expense.

13. ENGINEMEN:
    This to cover wages of locomotive engineers and firemen, traveling engineers and firemen, fuel experts and road foremen of locomotive engineers.

14. FUEL:
    Total cost of fuel as delivered on locomotives, as outlined in Column 5; this to include cost of all handling.

15. LUBRICATING:
    To cover cost of oil, tallow, grease and waste used in lubricating locomotives and tenders.

16. ROUNDHOUSEMEN:
    To cover cost of roundhousemen; those wiping, watching and dispatching locomotives; cleaning roundhouses and ash pits; turning table, firing up locomotives, filling and washing locomotive boilers, filling headlights, lamps and lanterns, drawing sand, etc.

17. WATER SUPPLY:
    Total cost of water as delivered to locomotives.

18. STORES:

Cost of all oil, waste, and rags used in lighting and cleaning lamps; headlight wicks and chimneys, lanterns and lamps used on locomotives; cost of repairs to movable furniture — cans, curtains, cushions, coupling bars, links, pins, switch chains and frogs, also tools carried on locomotives — hammers, axes, pokers, shakers, scoops, hatchets, jackscrews, etc., and supplies carried on locomotives — sand, torpedoes, etc.

19. TOTAL COST OF LOCOMOTIVE EXPENSE:

Total cost of all the items in Columns 12 to 18 inclusive.

20. TOTAL COST PER 100 REVENUE TON-MILES:

The several roads using this as a basis suggest 100, 1,000 and 10,000 miles respectively, as a unit; we believe 100 miles to be the best adapted.

21. NUMBER OF LOCOMOTIVES IN SERVICE:

Different methods of computing this item are in use by different roads; we offer the following as being satisfactory: First, determine the average number of locomotives in shop by dividing the whole number of days all locomotives were in shop by 30, dropping fractions of less than 15, 15 and over to count as a whole; then deduct this result, together with the number of unserviceable locomotives, from the total number of locomotives assigned.

22. AVERAGE MILES RUN PER LOCOMOTIVE:

The number shown in Column 21 being the divisor used.

23. TON-MILES (work done) PER LOCOMOTIVE (in thousands for convenience).

24. AVERAGE ASCENTS AND DESCENTS OF ALL GRADES PER MILE OF ROAD (Feet):

The objections offered to the ton-mile unit as a basis are, that the conditions on different roads vary so greatly as to make it unreliable, and the fact that cost on this basis is greater on mountain than on valley divisions is understood by all.

We find it impossible at present to equate the conditions referred to on any statement of this sort, and it is not claimed that this showing covers all objections.

25. PERCENTAGE OF BRANCH LINES TO TOTAL ROAD MILEAGE:

This is offered as a means of accounting for the difference in amount of work performed by locomotives on different divisions, it being claimed that on divisions made up of many branch lines locomotives are not able to obtain full loads.

For comparison of performance and expense with previous periods we offer the following comparison with same month of previous year.

26. COST PER LOCOMOTIVE-MILE EACH SERVICE:
Cost per locomotive-mile for passenger, switch, and work train service, figured on same basis as result in Column 19.

27. WORK DONE BY EACH LOCOMOTIVE (Freight):
Same basis as results in Column 23.

28. WORK DONE PER POUND OF COAL (Freight):
Same result as in Column 10.

29. COST OF SERVICE PER 100 GROSS TON-MILES (Freight):
Same basis as result in Column 19.

It is believed that the requirements of this form will not entail any additional clerical expense, as nearly all railway companies are at present furnishing necessary data in some form or other.

Respectfully submitted,
H. J. SMALL,
C. H. QUEREAU,
W. H. MARSHALL,
Committee.

THE PRESIDENT: Gentlemen, the paper is before you. What is your pleasure?

MR. L. R. POMEROY: I move that it be received and placed on file, and opened for discussion.

The motion was carried.

MR. C. H. QUEREAU: To give point to this discussion, and possibly to shorten it, I would offer the following resolution for action:

Resolved, That it is the sense of this Association that the ton-mile basis for motive power statistics is the most practical, and encourages economical methods of operating; and that it is desirable that the heads of motive power departments urge its adoption on their managements.

(Seconded.)

THE PRESIDENT: Gentlemen, you have heard the motion. Are there any remarks to the motion? All in favor of the motion say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: Do you wish to discuss the subject further, gentlemen?

MR. W. S. MORRIS: I move you, sir, that this committee be continued on this same subject. It is a matter of considerable importance, and we may get some new information every year. (Seconded.)

MR. QUEREAU: The chairman of the committee does not rise, and as a thought occurs to me, as a member of that committee I would like to ask, in respect to this motion, what is the end in view? Is it to devise methods of compiling ton-mile statistics? that is, as to whether the weight of the engine and the weight of the car are to be included, and a number of other minutiæ; or what are the special objects in view? I think it would be of advantage to the committee, in case it is decided to continue it, to have that information.

MR. G. R. HENDERSON: There is one point in connection with the ton-mile basis——

THE PRESIDENT: Mr. Henderson, you will excuse me if you please. I have not entertained the motion yet. As soon as I dispose of that, discussion will be in order. I might say, Mr. Quereau, for your information, that if there is no objection, we will refer your thought to the Executive Committee, and let them outline an order of work. The Secretary will make a note of that. The motion is that the committee be continued.

MR. SMALL: I understood the work this committee was to do was simply to report on the advantages of the ton-mile basis for statistics. They have reported to the Association, and the Association has, by resolution, adopted practically the ton-mile basis. I do not exactly understand what more the committee could do. If the mover of the resolution would explain thoroughly what the object was——

THE PRESIDENT: This Association knows a good thing, Mr. Small, when it sees it, and the Executive Committee probably will give you some light on that subject. They may have something for you to do. They would like to have the committee continued. All in favor of having the committee continued say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: Now, gentlemen, if you want to discuss the paper, please do so.

MR. J. F. DEEMS: Some few years ago I was quite enthusiastic on this subject. By the way, I seconded the motion of Mr. Quereau here in regard to the action of the meeting. I feel that the report is a very good one. There is little or no doubt that the ton-mile basis is the most accurate that we can use. I was impressed with the

remark that Mr. Barr made awhile ago relative to improved methods of boiler washing. He said it don't matter how good the methods are you adopt, they amount to nothing if they are not followed up. I think that is true of a great many statistics that are kept. They are handled in a perfunctory sort of a way. That is no criticism on the statistics, perhaps, but on reading a paper while coming down on the train I ran across something that impressed me so much that I cut it out and will take the privilege of reading it. It is from the *Railway Agent and Station Agent:*

> What practical railroad manager has not been deviled by the statistician — annoyed, bedeviled, disgusted? Yet the weary course goes on. Away up in the loft of some office at the cross-roads country station, in the grime and smoke of the store clerk's shop, overhead in the division superintendent's office, at the shipping clerks' desks, in the maintenance of way departments — everybody, everywhere, in some way or other, is making statistics. We have spent one dollar, and we spend two dollars more of the stockholders' money just to explain to them where the first dollar went to.

Well, perhaps that is overdrawn. But I believe there is food for thought in just what is said in that article, and in line with that there were some statistics in the issue of May 5 of *Engineering*, of London, that impressed me very much. I presume it is safe to say that there is no place in the world where more time is spent and more elaborate statistics are prepared than with our brethren across the water — that is, the English railroad men; and in this issue there were some statistics from one of the large English roads extending over the period from 1869 to 1898, inclusive. They were so elaborate and voluminous that I could hardly wade through all of them. But one point struck me very forcibly. Among other things it was stated that the average miles per engine in 1869 was 15,127 miles per annum. In 1896 it had gone up to the enormous figure of 15,527 miles. Now, there was a gain of one mile per day in thirty years, or a gain of two and a half per cent in thirty years, in the face of the fact that very elaborate and very complete statistics were kept during all this time, as was shown by the article I have quoted. I mention that to support what I said at the start, that quite often these statistics are handled in a perfunctory sort of a way. They are gotten out, laid aside, and succeeding papers are piled on them and we do not get the benefit there that we should. But that struck me very forcibly. Another point in connection with that is that during that period they had increased the power and size of

their locomotives very materially, and had increased the number of locomotives 88 per cent, while they had increased the mileage only one mile per day, or a little less than 2⅓ per cent in thirty years. I believe it would have suggested itself to some of our people in this country that we should increase the mileage rather than the number of locomotives. I realize that sometimes local conditions are such that they can not increase locomotive mileage as we do here, and it might be that they could not accomplish as much there as we have; yet it would seem that they might have accomplished more than one mile a day in thirty years.

Coming back to the report of the committee, it mentions the fact that about all that can be done is to compare one month, we will say, in the year 1899, with a month in 1898. Now, you can not even do that in many instances. You take it on a road with heavy grades, and in 1898 the bulk of the traffic is traveling, we will say, downhill, and in 1899 it is going uphill. You can not make any comparison there on a ton-mile basis. There is another factor that enters into it: When business is ordinary, or rather dull, we will say, it is an easy matter, for it is the practice to try and load the engines up to their full capacity; but the time comes when traffic becomes very heavy, and it ceases to be a question, "How much can you move in one train?" and becomes a question of how much you can move in a week. The result is that the train haul is reduced so as to increase the week haul. There you can not compare one year with another. So it seems to me that about the best way to handle the ton-mile rating, and in trying to spur the enginemen to better effort, is to compare the different men in the same service in the same month. We have watched it very carefully. I was quite enthusiastic, and worked a good deal on that line, and I have come to the conclusion that it is about all you can do in that way. There are so many elements that enter into it, when you come to compare it over a period of time, that I do not think you can handle them very successfully.

MR. L. R. POMEROY: It seems to me it is unsafe to argue from exceptions. If the principle can be established, the application of the principle ought to be looked to, to conform to the fundamental, if it is a fundamental principle, that a railroad has tons to sell and not miles, and inasmuch as the revenue is on the basis of ton-miles, the cost should be computed on the same standard. The plan proposed on the mileage basis is somewhat like a manufacturer keeping account of his shop-cost by the number of revolutions made by his shop

engine, and as it is clearly established that principles are eternal, and practice varies, it ought not to be difficult to raise the practice logically to conform to principle.

THE PRESIDENT: Mr. Deems, was not that an isolated case that you referred to? I have been advised by English railroad men that they are making as much as 10,000 or 12,000 miles a month and more with their passenger locomotive. Their passenger engines are making daily trips from London to Liverpool without stops, 217 or more miles.

MR. DEEMS: Well, if you will refer to London *Engineering* of May 5——

THE PRESIDENT: Don't you think that that was simply an article to ridicule statistics, and they took an isolated case?

MR. DEEMS: No; it was quite the opposite.

THE PRESIDENT: Did they say what railroad?

MR. DEEMS: If I recollect right it was the London & Northwestern, but I won't be sure of that. But the article was written for anything but to ridicule the idea of keeping statistics. It was a perfectly fair statement. It is quite possible that some of the figures showed very favorably and very differently from these. But this impressed me so much in face of the fact that in the last few years there has been such an effort made in this country to increase the mileage of our locomotives.

THE PRESIDENT: I did not want a wrong impression to go out, if it was wrong — if it was simply an isolated case.

MR. G. R. HENDERSON: If the committee is to be continued, as I understand from the resolution just passed, it seems to me that if they could do a little more work as indicated on page 8, the results would be beneficial. As we all know, it is worthless practically to compare even ton-mile statistics of roads or divisions which have different grades and different physical conditions, and if something could be done on the line which Mr. Johnston, of the Mexican Central, has attempted, then such comparison would be valuable. But I think it is almost worthless to make comparison, say, from a mountain road to a level road, or even from a mountainous division to a level division of the same road. People will look over the sheets and wonder why one division runs so much over the other in coal consumption, etc., and it is easily explained by the grade; but if that

information is not given, it will be difficult to make any comparison. If some unit could be adopted which would in a measure represent the average resistance on a section, and instead of having it in ton-miles have it in a certain function of resistance, then I think we would get some way of making comparisons. I do not know that the thing is practical, but I think it would be well for the committee to continue that, if it is to be continued.

A. E. MANCHESTER: Mr. President, I am in accord with the ton-mile basis of arriving at the work performed by locomotives in freight service, but I believe that these records can be made to subserve additional purposes — that of bringing the different departments of the railroad into greater harmony and making a more uniform responsibility all the way down the line by holding them all accountable in a measure for the ton-mile basis. It is on these lines that the C. M. & St. P. R'y is endeavoring to work out the mileage basis. We make each month a profit and loss sheet. A part of that profit and loss sheet is the loading of cars, and it shows very quickly that if there is any falling off in the number of tons that are loaded into cars per month — the profit and loss sheet directly shows up in that direction, and the department that is responsible for the loading of cars is brought into touch right away with their work in that direction. The hauling of empty cars over the line is another feature in connection with the same work. It hardly seems to me possible to make comparisons from one district to another, even though the comparison be made as the Mexican Central have been handling it. Many divisions of the road are not responsible for their not making a good performance, from the fact that they are locally so situated that they can not get good tonnage. Take the division that originates the freight. It starts out probably with the caboose and ends at the division terminal with a full train. The division that makes the run from start to finish with a full train must, of necessity, make a much better showing by the ton-mile basis.

MR. S. HIGGINS: I think the proper loading of cars, as referred to by Mr. Manchester, has an important bearing on ton-mile. Recently on the road I am connected with, that matter has been taken up. At one point where they had been sending out thirteen cars a day they have boiled that down so that the same amount of freight is taken out in five cars. As the committee is to be continued, I would suggest that the members of the committee should

consider the classification of operating expenses by the Inter-State Commerce Commission. I note, for instance, under the heading of "Enginemen" are included road foremen of locomotive engineers. If I am not mistaken, the wages of road foremen of locomotive engineers should be charged up against maintenance of equipment, or in other words, against the repair account. I think, too, a more accurate method might be adopted for figuring out the number of locomotives in service. We have been in the habit of figuring it out in this way, for instance: if a locomotive is in service one day in a month — there are thirty days in a month — that locomotive counts as one-thirtieth of an engine. In that way you will get more accurate results, I think, than in following out the rules contained in paragraph 21 on page 11.

THE PRESIDENT: Are there any other remarks on the subject?

MR. DELANO: I merely want to ask the committee to take up one other phase of this subject, and that is, in computing the tonnage of a train shall the weight of the engine be included with the train? I know the practice on two or three roads that have adopted this tonnage basis is to include the engine. The practice, doubtless, of others is not to include it. I think there are a good many arguments both ways, and I would like to have them go into that subject pretty fully.

MR. R. H. JOHNSON: Noting the arguments on the subject pro and con, I think that the main thing would be to get a rule that would be applicable to the different lines of railway service, and as all freight is practically paid for on a tonnage basis, where we can readily adapt it to our business, we will have something then that will be comprehensive. As it is now, each and every one makes his account and his statements to compare with his last year's work or some preceding year's work and necessarily follows the same line of comparison, so that he might show whether he has been successful or not. Consequently the fact of having adopted the ton-mile basis would not in any way interfere with our business, but it would show others wherein they could benefit by taking advantage of such parts and times as would present themselves whereby they could increase the tonnage of the car and decrease the car mileage. I think that is one of the objects that should be taken into consideration in this question.

MR. QUEREAU: This is a very broad subject, and one in which a proper conclusion will not be arrived at in a moment or in the next

year or two. It is evident to any one that not only should the weight moved and the distance to which it is moved be included in the unit for comparison, but also the speed at which it is moved, or the time element. I am rather doubtful, though, whether we would be allowed to go into such refinement as to include the speed, which is a very important element. That will be partially compensated for if the suggestion made in the report is adopted, that the different classes of service be tabulated together; passenger service, for instance, by itself; freight service by itself. I believe the wise thing to do is not to eat our apple all at once, but to start with that foundation and the information that we have. There are a few things which seem to me important in this connection. I wish to differ slightly from the report where it states on page 8: "While the foregoing argument clearly illustrates the fallacy of computing the work done by locomotives on the locomotive-mile basis for intelligent comparison, and the great advantage gained by the use of the ton-mile unit in freight service, there is a strong tendency to question the advisability of the ton-mile basis in passenger work and switch service." I really see no good reason why, if the ton-mile basis is applicable to freight work, it is not equally applicable to passenger work and switch work. On the present basis of cost per mile, we give a switch engine arbitrarily six or eight miles an hour; why not give that switching engine an arbitrary ten miles per hour, or, what is better still, derive the work done in ton-miles by the switching engine from our freight ton-mile statistics and our passenger ton-mile statistics? For instance, at most points one switching engine does nothing but freight work and another will do nothing but passenger work; at the end of the month we will know the number of passenger ton-miles. Why not from that determine the number of ton-miles of work done by our switching engine? I fully appreciate that that would not be accurate, but I am equally confident that it would be much more accurate than giving an engine an arbitrary six miles an hour. The same thing is true so far as switching engine service is concerned. I see no reason why the switching engine can not be asked to give a number of ton-miles each month depending on the number of ton-miles of freight work done.

There is another matter, I think, that although not vital, is worth taking into account, and that is this: In most motive power statistics, the replacement of engines destroyed is charged to repairs, and appears in the cost of repairs per engine-mile or ton-mile, or whatever that may be. Some roads make a separate item of this on their

statements, and I believe it is wise. If we include in the cost of repairs new engines built or bought to replace those destroyed, we lose track of the month at least, or spoil the per cent for the next year of the actual cost of the repairs of the engines in service. The new engines should certainly be charged to engine repairs, but why not make a separate item of that, so that by so doing we can tell what the actual repairs are? It also seems to me important that the ton-miles for branch lines should be made separate. The Burlington has a system of statistics on the ton-mile basis on which the freight and passenger ton-miles of main line engines are given. Also the same figures for branch line engines. It seems to me that this is quite important, and would involve practically no more clerical work — simply one more footing. I believe that the greatest benefit to be derived from the ton-mile basis will be the co-operation of all departments. The time was, not very long ago, when the motive power department belonged to itself. The feeling was: "I am a member of the motive power department. I shall protect the motive power department whether it advances the welfare of the road with which I am connected or not." We insisted — I do not mean to say that any one here did, of course; I never did — we insisted that trains should be made as light as possible. The engineers would be sustained in kicking if we put on one more car than we should. The ton-mile basis would do away with that. We are coming to realize that the motive power department is simply an auxiliary, an adjunct, of the operating department; that all departments must work together to reduce operating expenses. I believe the greatest benefit of the ton-mile basis will come from this view of it.

MR. MCINTOSH: I simply want to say a word suggested by Mr. Henderson's remarks. I had some difficulty at one time to determine why the cost on one division in my charge exceeded that on another, and I could only reach a conclusion by reducing the grades on either division to an average, and comparing them. By so doing, I found what I thought was the cause of the difference. I fancy that is a matter that will have to be taken under consideration in coming to any uniform basis.

THE PRESIDENT: Are there any further remarks, gentlemen?

MR. MCCONNELL: I move that the discussion be closed.

The motion was carried.

MR. HUMPHREY: Mr. Chairman, I move that we adjourn.

THE PRESIDENT: If we adjourn, gentlemen, I want to include in that motion 9 o'clock tomorrow morning.

MR. HUMPHREY: I thought the by-law provides that.

THE PRESIDENT: It does; but we have been making exceptions to it.

The convention then adjourned until 9 A.M. on the following day.

THIRD DAY'S PROCEEDINGS.

The convention was called to order on Wednesday, June 21, at 9:20 A.M.

THE PRESIDENT: The convention will come to order. The Secretary has a communication to present, to which we should be glad to have you listen.

MR. CLOUD: It is from Chattanooga, Tenn., from the Treasurer of the National Relief Committee:

CHATTANOOGA, Tenn., June 15, 1899.

The American Railway Master Mechanics' Association, Old Point Comfort, Va.:

GENTLEMEN,—June last the National Relief Committee at this place received from your treasurer, through Mr. V. B. Lang, a very generous donation of one thousand dollars. This was at the time acknowledged, but we desire to again acknowledge to your general meeting and to thank you most sincerely for the same.

This money was expended by our committee, along with thousands more, generously contributed, in the purchase of necessary supplies and comforts for the sick soldiers then encamped at Chickamauga. We know that much good was done by our committee, and believe the knowledge of this fact will be your sufficient reward for the same. Very truly yours,

F. F. WEIHL,
Treasurer, National Relief Committee.

This was not donated from the treasury of this Association, but it was a collection made at the last convention, and I think forwarded by the agency of the supply men here — individual donations from members and others. I understand it was forwarded by Mr. Quayle, but what I said before is correct, that it did not come from the treasury of the Association. It was donations made by members and others at the convention last year.

THE PRESIDENT: I will take the opportunity, gentlemen, of saying that the supply men had a very important part in that. In fact, they contributed very largely, and to their generosity is very largely

due the results that were obtained. Mr. McConnell was one of the active members, as you remember, in that. He hustled everybody in that he could.

MR. CLOUD: I would move that this communication be turned over to the chairman, if there is one, of the lobby association for its information. (Seconded.)

THE PRESIDENT: Gentlemen, you have heard the motion, that this be turned over to the chairman of the Supply Men's Association. I believe that to be Mr. E. S. Marshall. All in favor of that say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: Before we take up our usual business, is there anything that any member has to offer?

MR. L. R. POMEROY: Mr. President, I have a resolution I would like to offer with reference to one of the recommendations in our president's annual address where he said, "I would like to recommend that a committee be appointed to report at the next convention upon the subject "What can the Master Mechanics' Association do to increase its usefulness?" I would respectfully move that this subject be referred to the Executive Committee with instructions to appoint such committee.

(Seconded.)

THE PRESIDENT: You have heard the motion, gentlemen. I might say that I have more in mind concerning that than appears in that little item. There have been a number of suggestions made to me which I think if carried out would probably, very largely at least, facilitate the work of the convention as well as improve its usefulness. All in favor of the motion that the subject of increasing the usefulness of the Association as referred to in the President's address be referred to the Executive Committee for consideration.

MR. POMEROY: The motion is probably a little more than that—with instructions to appoint a committee for this purpose.

THE PRESIDENT: With instructions to appoint a committee. All in favor of that say "aye"; contrary, "no."

The motion was carried.

PROF. H. WADE HIBBARD: I have a resolution to offer of somewhat similar nature to the one just adopted, as follows:

Resolved, That a standing committee of three members be appointed by the President to report at each annual convention upon the extent to which the recommendations of this Association have been put in practice. It shall be the duty of this committee to use suitable endeavor in gathering its information to impress upon the members of the Association the value of the findings of the Association in committee reports and their discussions.

(Seconded.)

THE PRESIDENT: Gentlemen, I do not know that it is necessary to read that again; you know the sense of it. It is to the effect that there are a great many recommendations made that are of value that are passed over unnoticed, and there is a good deal of work being done that we do not follow up. Now we have had some valuable papers presented here this time. Take the one presented by Mr. Manchester yesterday; it would be a very good thing for us to know in a year or two from now what has been done in that regard. The resolution, I believe, is to cover work of that nature.

PROFESSOR HIBBARD: Just a word that I would add to that — that it has been my experience in railroad club meetings, as well as here, that reports and papers are made and presented to the clubs or to the associations which are overlooked — which are not remembered. There was a paper presented at the New York Railroad Club recently in which some matters were taken up with regard to the working of boiler steel at the blue temperature, and calling attention to its evils, and yet that matter was not a new matter at all, but had been handled many times before. But the boilermakers either had never read it or forgotten all about it. Now it seems to me that if we had a committee like this to keep these matters before the members of the Association in correspondence, it would be greatly conducive to the adoption of the recommendations of the Association, and even where we have not made definite recommendations this committee will find a valuable work in its correspondence in getting its information about the adoption of our recommendations; it will find a valuable work in calling the attention of members of the Association, both those who are here and the many who are not here, to the facts which have been brought out by our reports and discussions.

The resolution offered by Professor Hibbard was then put and carried.

THE PRESIDENT: Now, if there is nothing more to come before

the convention in that order we will take up our usual business. The next subject to be taken up is No. 5: "Best Method of Applying Stay Bolts to Locomotive Boilers, Including Making the Bolts and Preparing the Stay Bolt Holes." Mr. T. A. Lawes is chairman of this committee. I would be glad to have him come up here and present the report.

Mr. Lawes presented the following report:

REPORT OF COMMITTEE ON BEST METHOD OF APPLYING STAY BOLTS TO LOCOMOTIVE BOILERS.

To the President and Members of the American Railway Master Mechanics' Association:

Your committee on "Best Method of Applying Stay Bolts to Locomotive Boilers, Including Making the Bolts and Preparing the Holes," respectfully submits the following report:

Through the medium usually employed—the circular of inquiry—the committee has obtained the experience of many of the members, and for which it wishes to express its thanks. The replies to the questions show that they were carefully prepared with a view of furnishing the committee all information required.

To "begin with the beginning," it has been thought best to submit the report showing, first, the process of manufacture of stay bolts, and to that end the subject will be considered under the several headings to indicate the same.

CUTTING STAY BOLTS FROM THE BARS.

The general practice is to cut stay bolts off to the required length by a concave cutter in a shearing machine. The Pennsylvania Company cuts them off in a turret lathe. The C. C. C. & St. L. R'y uses the device shown in Fig. 1. The advantage in the use of this device is that the bolt is held more firmly, while being sheared, than in the ordinary concave shears, and it cuts the ends off squarely. When the concave cutter is used there is more or less tendency for the stay bolt to raise up while shear is cutting, and the result is the end is not cut off squarely.

There is no patent on this device.

MAKING SQUARE ENDS ON STAY BOLTS.

The usual method of making square heads is by the use of a bolt header. The Buffalo & Susquehanna R. R. makes them with dies under a steam hammer; the Chicago, Burlington & Quincy R. R. mills off square at end of stay bolt; the Chicago & North-Western R'y makes the square with a punch under shears; the C. C. C. & St. L. R'y does the same with the device shown in Fig. 2. Heads can be put on with this device by one man at the rate of 300 per hour. An ordinary bolt header can do this work at the rate of 300 per hour, requiring, however, one man and a helper to operate it.

HEADLESS BOLTS.

Several members report that they do not square ends. The stay bolts are screwed into boiler by the aid of various devices. The Chicago, Burlington & Quincy

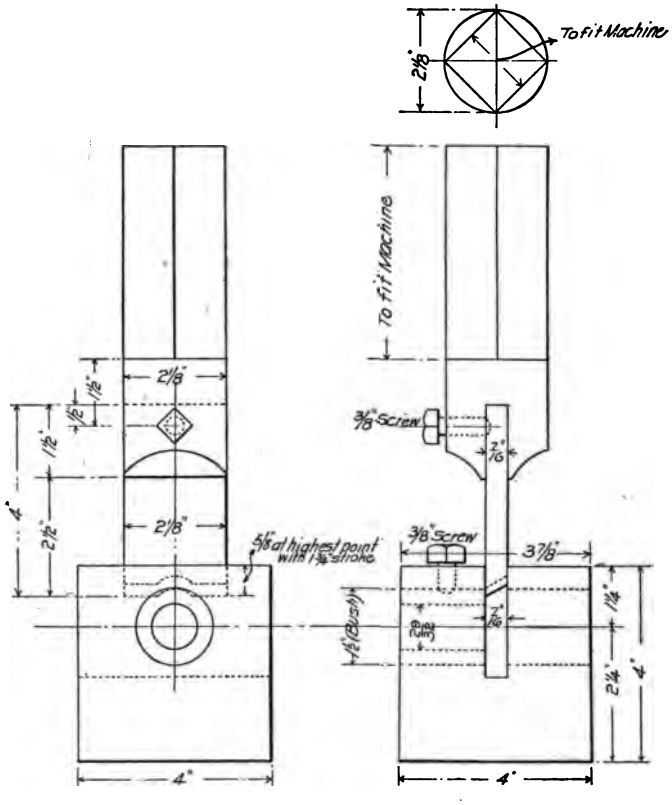


FIG. 1

C. C. C. & St. L. Ry.

DEVICE FOR CUTTING OFF AND SQUARING ENDS OF IRON FOR STAY-BOLTS.

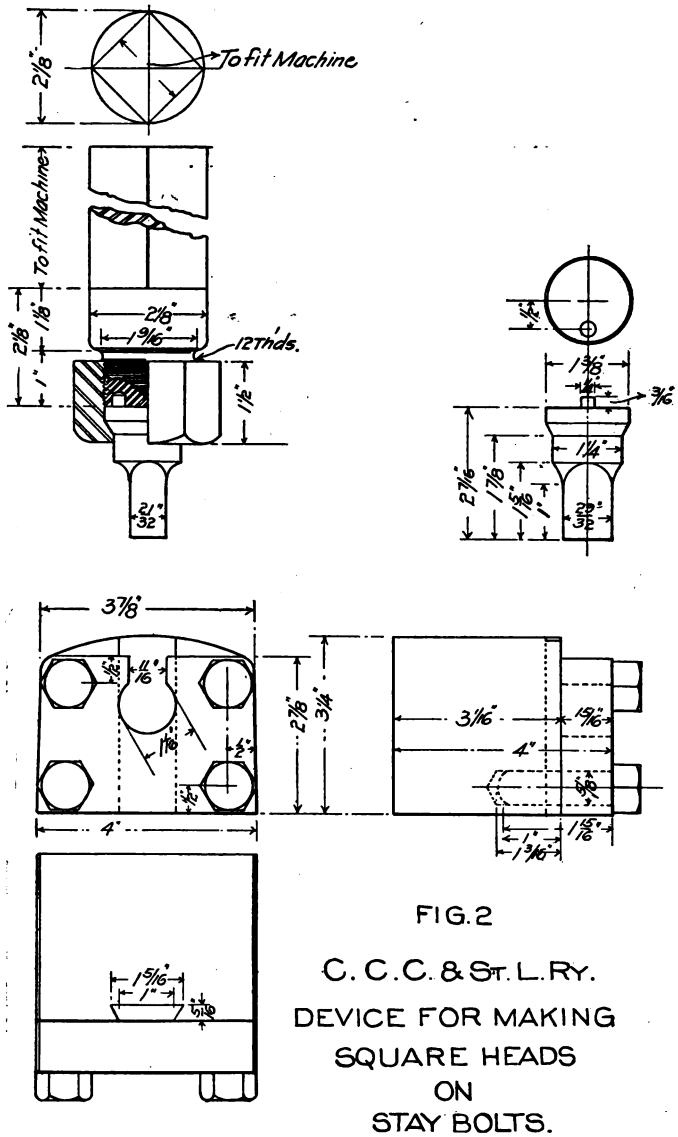


FIG. 2

C. C. C. & St. L. Ry.

DEVICE FOR MAKING SQUARE HEADS ON STAY BOLTS.

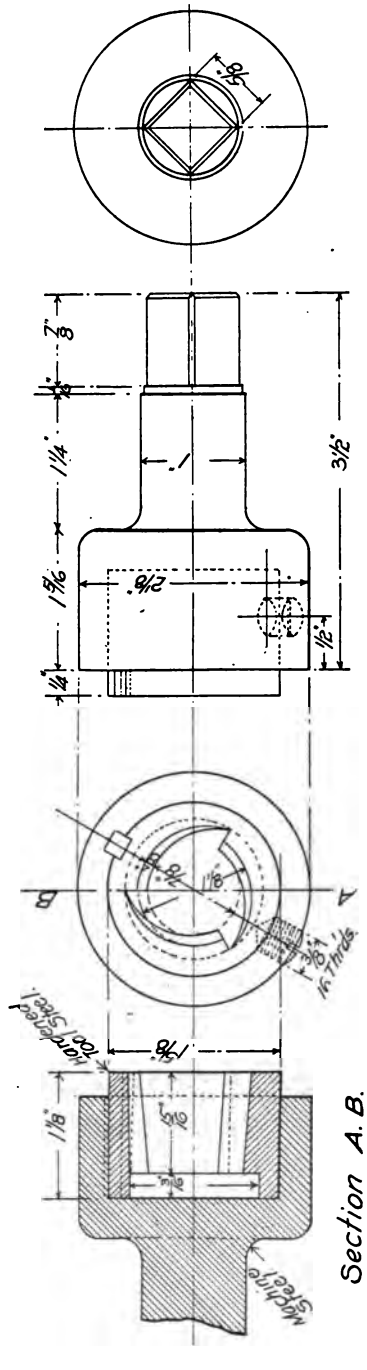


FIG. 3

STAY-BOLT CLUTCH

A. T. & S. F RY.

R'y uses a patent eccentric die, and the Chicago & West Michigan R'y uses a chuck for this purpose. The Northern Pacific R'y reports the use of a device for screwing bolts into fire box.

The device used by the Atchison, Topeka & Santa Fe is shown in Fig. 3. It is not patented.

The Chicago & Eastern Illinois R. R. has tried headless bolts, but has abandoned their use, for the reason that after screwing them in with an air motor an adjustment must be made by the use of an alligator wrench in order to move the bolt just far enough to properly rivet it. The time used in adjusting and removing the alligator wrench more than balances the cost of forging the square ends on bolts.

CUTTING THREADS.

The Chicago, Milwaukee & St. Paul R'y report the use of a six-spindle cutting machine — running the bolts through twice; the first time roughing them down very nearly to size and the second time with dies that are in perfect condition — only requiring to straighten up, and cutting but little additional thread.

The Delaware & Hudson Canal Company also take two cuts on stay bolts — the second cut being a very light one to finish. A better thread can be obtained by this method, though the usual practice is to take but one cut over a stay bolt.

A number of roads report the use of a lead screw attachment an essential to produce stay bolts with threads of accurate pitch, viz: Erie; Lehigh Valley; Baltimore & Ohio; Grand Rapids & Indiana; Chicago Great Western; Delaware, Lackawanna & Western; Chesapeake & Ohio; Penna. Lines west of Pittsburg; Philadelphia, Reading & New England; Minneapolis, St. Paul & Sault Ste. Marie; Northern Pacific; Rio Grande Western; Chicago, Rock Island & Pacific; Buffalo & Susquehanna and Chicago & Eastern Illinois.

The lubricant reported as giving the best results in cutting stay bolts is lard oil. Summer cottonseed oil is as good, and dies will remain sharp as long with it as with lard oil, but after bolts are cut it is more liable to gum over the threads. This, however, has not been considered objectionable, except when bolts are prepared and stored for some time before they are used. The Lehigh Valley R. R. reports that the best lubricant they have found is two-thirds raw linseed oil and one-third signal oil. The Chicago, Milwaukee & St. Paul R'y uses bolt-cutting oil which consists of 60 per cent Natural West Virginia oil, 15 per cent fish oil and 25 per cent No. 1 lard oil. This was found entirely satisfactory.

SPECIAL FORMS OF STAY BOLTS.

The Erie R. R. uses upset ends on radial stays; the Chicago, Burlington & Quincy R'y turns stay bolts down in center with a Niles screw machine; the Boston & Maine R. R. swages them down in the middle instead of upsetting the ends; the Rio Grande Western R'y cuts them down in center below bottom of threads in a bolt cutter, with blind dies, working with a lead screw; the Chicago Great Western R'y reports the use of crown sheet stay bolts with threads turned off in the middle — the work being done in a turret lathe; the standard practice of the Lehigh Valley R. R. is to upset both ends for about one inch, on which threads are cut, the center of bolt being left blank; the Northern Pacific R'y reports that all long stay bolts are turned smaller in diameter at center than at ends, the work being done on a "Gisholt" machine; the Union Pacific R'y turns stay bolts down in center in a lathe.

PREPARING STAY-BOLT HOLES.

The following roads report preparing stay-bolt holes in fire boxes by first punching them smaller than required size and then reaming them to size — thus removing disturbed metal, viz: Delaware & Hudson Canal Company; Chicago & North-Western; Lake Shore & Michigan Southern; Missouri Pacific; Minneapolis, St. Paul & Sault Ste. Marie; Delaware, Lackawanna & Western; Chicago Great Western; Lehigh Valley; Norfolk & Western; Chicago, Milwaukee & St. Paul; Northern Pacific; St. Louis & San Francisco.

The following roads report drilling stay-bolt holes in fire boxes, viz: Chicago & North-Western; Cleveland, Lorain & Wheeling; Erie; Chicago, Burlington & Quincy; Duluth, South Shore & Atlantic; Southern; New York, Ontario & Western; Buffalo & Susquehanna; Chicago, Rock Island & Pacific; Penna. Lines west of Pittsburgh, and Grand Rapids & Indiana.

A large number of roads report the use of ordinary stay-bolt taps. A number, however, claim advantages in the use of the "Echols" patent stay-bolt tap made by Pratt & Whitney. The principle of this tap is the omission of each alternate tooth; each cutting tooth is followed by a space which gives a freedom of action to the cutting teeth, impossible in the old style, thus decreasing the resistance from 30 to 50 per cent.

"DETECTOR" HOLES IN SOLID STAY BOLTS.

The general practice is to drill stay bolts after they are in position. A few members report punching these holes by means of a steel-wire punch in a bolt-heading machine. The Chicago & Eastern Illinois R. R. uses an air motor attached to a framework allowing the drill to be set at any angle. This device is illustrated in Fig. 4.

In making and applying stay bolts to locomotive boilers, two important factors must be carefully considered: The stay-bolt tap and the hob tap which cuts the dies in bolt-cutting machine must be true to pitch, and then the machine must have some special device for making the threads true to pitch. Cutting stay bolts true to pitch is a subject that deserves more investigation, we think, than any other detail connected with making and applying them properly. The weak point in a great many shops is in cutting stay bolts untrue to pitch. It has been found that accurately pitched dies will not produce true-pitched bolts.

Pratt & Whitney write the committee that "the problem of making a tap with long thread and keeping that thread to approximately correct lead has been a very annoying one to us, and doubtless to others, and is still annoying, for the very reason that we cannot rely upon the extent to which steel will change and the manner in which the change will take place. We overcome this very largely, however, by having carefully annealed steel to begin with; having the annealing as uniform as possible, and threading the tap with a screw which is made expressly for the work, and which has an error approximately the error which takes place in the tap in the hardening operation; i. e., long experience teaches us that steel will change in a certain direction. In the great majority of cases this direction is toward the shortening rather than the lengthening. We accordingly make the lead screw of our lathe long, as stated above, to compensate for the shrinkage or shortening that will take place in the steel when hardening. We very often have to give the tool a double

shrinkage in very special cases. What we mean by double shrinkage is hardening the tool and reannealing before the final finish, threading on all important taps that have any special length of thread. We confine the error to .0015 per inch or .018 inch per foot."

Correctly cut dies alone will not cut true-pitch stay bolts; to insure stay bolts being cut true to pitch, two methods have been employed: A lead screw attached to the carriage of a bolt-cutter is one way to accomplish this, and the lead-controlling feature employed by the Jones & Lamson Machine Company in the dies used in flat-turret lathe made by them the other.

The Acme Machinery Company writes the committee as follows:

"All dies that we have any knowledge of gain threads and lose pitch when cutting threads. Some of our expert diemakers can grind a set of dies so that they can be made to do 'most anything,' but that does not help the 'rank and file,' into whose hands such a machine falls. All kinds of schemes and contrivances have been made and used in trying to correct the disposition of a set of dies to cut out of pitch. Supposing, for instance, the rear teeth of a set of dies would act as a nut; they would certainly begin with an error, because the leading teeth are apt to begin with more or less error, as they 'nibble' at the end of a bolt."

At the New York meeting of the American Society of Mechanical Engineers, in December, 1897, Mr. James Hartness, of Jones & Lamson Co., read a paper on a stay-bolt threading device which has some valuable features, especially for radial stays, where there are threads on both ends of stay bolts and long blank spaces between.

We quote from the paper: "The scheme may be briefly and perhaps completely described as 'Tandem' dies for simultaneously threading both ends of a stay bolt to insure correspondence in lead. These tandem dies are designed for use in a turret lathe, and cannot be applied to a bolt cutter." Mr. Hartness further states that: "Stay bolts are mostly cut by dies permitted to control their own lead; occasionally, however, a lead screw is used to govern the pitch of the die. The lead-screw scheme seldom controls the lead of the die at the beginning of its cut, on account of the slackness of the slides and intermediate connections; hence the die usually has a chance to cut a very incorrect lead before the screw has taken up the 'slack' and 'spring' of intermediate parts." The dies are described as follows: "The teeth at the front of the die have a cutting clearance, while the teeth at the back of the die have no clearance, but instead, ride on the thread and control the lead. So accurate is the lead-controlling feature that regular dies for market seldom have an error in lead greater than $\frac{1}{64}$ inch in 18 inches, which is less than $\frac{1}{4}$ the average error in standard taps."

The committee has samples of screw-cutting done by the use of a lead screw on a bolt cutter, and also by the use of a Hartness die. Both methods give equally good results, so far as can be judged by the samples.

The investigations of the committee lead it to believe that the best method of making and applying stay bolts is as follows: Cut the stay bolts from the bars by means of a shearing machine; make square ends by the use of a bolt-heading machine, or punching the metal from the bar to form a head; cut threads in a bolt cutter, having a lead screw, or on a turret machine having special dies that will cut true to pitch.

For a cutting lubricant, lard oil is the best, with yellow cottonseed oil a close second.

In preparing the stay-bolt holes, we recommend that: In the fire box, they should be drilled; in the shell of boiler, punched ⅛-inch smaller than required size and the remainder reamed out with a reamer on end of stay-bolt tap. Holes should be tapped with some form of air or electric motor, and stay bolts screwed in with same device.

We also recommend that stay-bolt taps, and hob taps for cutting stay-bolt dies, be purchased from some reputable maker in preference to making them at a railroad shop. Stay-bolt and hob tap making requires special skill and most accurate tools, which are not always available at railroad shops.

For cutting off stay bolts, no device appears to answer for all bolts. The best practice seems to be as follows: Where bolts are of uniform length, and are at right angles with sheets, as in vertical water space surrounding fire box, it is best to "nick" the bolts in a lathe to the right length; after being screwed into place a slight tap on the end is sufficient to break them off. For bolts that require to be cut off at an angle, an electric saw can be used to advantage; as in cutting off radial stay bolts, outside of boiler. A pneumatic cutting machine can be used to advantage for cutting off bolts of variable lengths after they have been screwed into place, where it would not pay to handle them singly in a lathe or cutting machine.

The committee knows of no better way of riveting stay bolts than the well-known method with the common hammer, and a holding-on hammer at the other end of the stay bolt. It is the committee's opinion that some form of air motor for drilling the "detector" holes in stay bolts is preferable to punching them. The objections to punching detector holes is that while stay bolts are being riveted the holes close up and require to be opened with a drift. When the bolt is drilled after it has been riveted there is no further work to be done. Respectfully submitted,

THOS. A. LAWES, Chairman,
GEO. F. WILSON,
S. M. VAUCLAIN,
Committee.

After reading the report, Mr. Lawes added: Mr. Leeds is the only man that touched on the subject of fitting of stay bolts, and he said that his practice was to not run the stay bolt tap entirely through both sheets, but stop it from going through the inside sheet of the fire box, and thereby making steam-tight fits of stay bolts for some three or four rows of stay bolts from the bottom.

THE PRESIDENT: Gentlemen, the report of the Committee on the Best Method of Applying Stay Bolts to Locomotive Boilers is before you. What is your pleasure?

MR. DAVID BROWN: I move that the report be accepted and opened for discussion?

The motion was carried.

THE PRESIDENT: Gentlemen, it is open for discussion. I hope you will be prompt and speak right to the subject.

MR. S. HIGGINS: Mr. Chairman, the committee, in the last paragraph of this report, recommends that the detector holes in stay bolts be drilled instead of punched, in order to avoid having the holes closed up when the bolts are being riveted over. There is another good reason for drilling the holes instead of punching them. During the past fall and winter we have been making a number of experiments with stay bolts to find out first what material gave the best results; then having determined that, to find out what form of bolts gave the best results. We had a machine rigged up for a vibrating test where we had all the conditions the same as in the boiler, with the exception of hot water and steam, and we found that where the hole was drilled instead of punched the number of vibrations required to crack or break the bolt was much greater, and there was no way of accounting for it except probably some little upsetting of the iron at the bottom of the hole when the punching was done.

MR. T. R. BROWNE: Under the head of the method of applying these tools, I see no comment in this report on the fact that the inside and outside sheets, unless proper care is used to tap these sheets at points, will be spread apart or thrown out of their natural or normal condition. About two years ago I made a test of this matter and found that starting from one end of the fire box, with a regular tap for this purpose, which has a reamer on the end and the threads are tapered back, finally coming to a straight thread, that after the outside sheet had been tapped through, and the tap had entered the inside sheet, beginning to cut the thread, it was being fed into that sheet at the rate of, say, one-twelfth of an inch to a revolution, which is a very much greater feed than we allow for any such purpose of reaming metal in any of our regular machines. By tapping this line of holes right across the length of the fire box, I found that the inside sheet, by measurement, had deflected as much as five-sixteenths or three-eighths of an inch. I also found that it was sometimes the practice to follow up the holes tapped with bolts to be screwed in, these bolts being put in as permanent stays or struts and they keep the sheet in this unnatural position. The result of this has been the adoption of what we call a hook bolt, which we can put through the two sheets, a nut on one end of it and a hook on the other, and which will have the effect of holding these sheets in their normal position while the tapping is being done.

MR. MANCHESTER: Mr. Chairman, I do not notice in the recommendations or in the paper any reference made to the speed at which the stay bolt holes shall be tapped out. In the present days of electric motors and air engines this possibly may cut some figure. I would like to know whether the committee obtained any information in their research as to whether there was any limit of speed at which it was not advisable to run the tap.

THE PRESIDENT: Will Mr. Lawes answer the question?

MR. LAWES: The committee made no special inquiry in that regard. As far as I am concerned personally, I would run them as fast as I could, taking into consideration the durability of the taps. I think that will have to be left to individual judgment; if different materials, different kinds of taps should be used. That is all I can say on that subject.

MR. G. W. WEST: I would like to ask the committee whether it had any data with regard to this special tap of Pratt & Whitney's, whether they had any better or worse results with the stay bolts tapped with that form of tap, and whether they had any more difficulty in keeping them tight.

THE PRESIDENT: He wants to know, Mr. Lawes, if you have any data concerning the Pratt & Whitney taps, if they are any better or if you found any difficulty in the use of them.

MR. LAWES: The resistance of the tap in tapping a hole with the Pratt & Whitney tap is thirty or forty per cent less than with an ordinary tap, and we have had no difficulty whatever in the use of the tap.

MR. WEST: That was not the point, Mr. President. There is no question but that they can tap the hole out quicker, but whether the stay bolts were as durable is what I wanted to find out.

MR. LAWES: No, sir; we have no data in that regard. It is only a recent invention, you know. We would not be liable to have very much on that.

MR. MANCHESTER: On the question of that special tap, I have no data as to the results obtained by the stay bolts screwed into the sheets; but a close inspection of the thread in the hole shows that in about every fifth or sixth hole there would be a part of the thread missing, or torn out.

MR. GILLIS: That is exactly our experience. We tried those

same taps. Those were the very things we were looking for and anxious to try. We found that the shavings from the cutting of one tooth would not clear, but would come in between the two teeth of the clear part and take out part of the thread, and would not give a good, clean thread in the sheet at all, and we simply had to abandon them. I notice a good many here use a lead screw on their machines. I have tried the lead screw on the machines and I do not think the lead screw on a good machine is necessary at all. In fact, I think if anything it is rather a bad thing than a good thing. If you have your lead screw on your machine and you have your die held in your head, those two must work absolutely together; whereas, if you simply have a good cutting die that die conforms with the screw itself. We have cut stay bolts with a thread eighteen to twenty inches long that so far as we could see by accurate measurement were absolutely perfect. Another thing that I think might be of some interest to those who have not examined them carefully is to go back home and examine all your standard taps. We once ordered in the market stay bolt taps from every known maker of any reputation whatever, and we only found two taps out of all of them that were anything like right; and those that we expected to find absolutely right we did not find right. We found some of them right, but they were not absolutely right.

MR. DAVID BROWN: The committee, I see, recommends putting squares on the ends of stay bolts. That is our practice, but we have been asked on occasions why we square them — why we do not screw them in round — have a grip on the air drill for that purpose. I would like to know if any of the members use that, or whether they think it is preferable to a square?

MR. SOULE: Mr. President, the committee has recommended that the detector holes in the stay bolts should be drilled rather than punched, but the reason they give is that it is annoying to have to punch detector holes with a drill after the stay bolts have been riveted in place, and I infer from that that their recommendation is that the detector holes should be drilled after the stay bolts are in position, after they have been riveted in position. But, of course, there is another alternative, and that is to drill the detector holes before the stay bolts are put in position. Now, when this matter of detector holes in stay bolts became recognized as an almost everyday feature of practice, the Baldwin Locomotive Works, in

looking about for a way to do the work cheaply, decided, after making some experiments, to punch these holes, and they did so in the bolt-heading machine and continued to do so for something over a year, until they had occasion to fit up a new shop to be specially devoted to the production of bolts, stay bolts included, and when they were fitting up that shop they provided some special tools made for the purpose, and since that time they have been drilling the detector holes and the stay bolts, and I would like to call attention to this, as that certainly seems to be just as good practice as regards the effect on the stay bolt itself as it is to drill after the bolts are in position. Of course, it still makes it necessary to open these holes by the drift after the ends of the stay bolts have been riveted over; but in adopting the practice of drilling the holes in the shop, you at least meet the point made by Mr. Higgins and avoid any distress of the metal by punching.

MR. F. SLATER: Mr. Chairman and Gentlemen,—I would like to emphasize the remark made by Mr. Soule just now in regard to drilling the stay bolts in the shop. Drilling stay bolts after they are screwed in is not satisfactory, for the reason that they are rarely even in the center of the bolt and hardly ever in line with the center of the bolt. Stay bolts, as a usual thing, excepting on the flat surfaces, are not perfectly square with the sheet, and a man drilling a stay bolt with a brace drill or any other kind of a drill is apt to rnn considerably to one side before he gets to the depth required, and the objection of opening the hole with a center punch after it is screwed in and riveted over is more than offset by the better work.

MR. J. H. MCCONNELL: Mr. Chairman, it has been our practice for a number of years to drill holes in the stay bolts before they are screwed in the fire box. We rigged up a machine at Omaha purposely for drilling the bolts. We can drill in that machine a hundred stay bolts an hour. It is operated by a belt, and also by compressed air. The bolt is fed up against the drill and backed off by the use of air. We put no heads on our stay bolts. They are cut off in the shears and taken to the machine and drilled, and then cut. We screw them in from the inside of the fire box by a special chuck. That gives the exact length of the bolt on the outside, and they are cut off with a pneumatic nipper on the inside of the fire box. We do not find any objection to what was referred to by Mr. Higgins, closing up the holes on the outside, because by the use of a small taper punch, the safety

hole is opened out. In our shops where we do not have this special machine, we are rigged up to drill the stay bolts after they are screwed into the fire box. In regard to Mr. Brown's remark, I will say that in putting our fire boxes in we scatter a few stay bolts here and there over the sheets in order to hold them, and we find that it is an advantage to do that, and we also find it is an advantage to screw the stay bolts in from the inside of the fire box.

MR. G. W. WEST: I would like to ask Mr. McConnell whether he ever tried screwing stay bolts in from the inside, and then cutting them off with an ordinary chisel, as most of the small railroads are obliged to do, and whether that practice was followed by any bad results. It seems to me that the whole secret lies in screwing the stay bolt in from the inside, if you are going to drill the hole, and if you are obliged to cut the stay bolts off in the manner most of the railroads are doing, it seems to me that is a serious objection; pounding the stay bolts on the inside of that thin sheet, is much worse than it would be to cut them off on the outside.

MR. MCCONNELL: No, sir; we have never cut them off with a chisel on the inside. Fortunately, we are equipped with air for the purpose of cutting them off. We have made an air machine with a double piston, which gives us a great deal of power, and we can get into the corners without any difficulty. The shears are on an angle, so that we can reach nearly every stay bolt in the fire box with this tool. The only times that we have cut stay bolts off are on the outside where they are screwed in from the outside sheet — never from the inside.

MR. MANCHESTER: I do not know whether it is germane to the subject, but I believe it is generally the practice everywhere to either drill or punch the stay bolt. We do the same thing, and yet our observation is that it is a good deal more ornamental than useful. I believe in our practice we find possibly one stay bolt a year broken from the detector hole. Now, whether this is caused by the use of soda ash and the particular water conditions that exist on our road, I am unable to say. But that is the experience and the facts of the case with us.

THE PRESIDENT: It spoils theology, doesn't it?

MR. LAWRENCE: For the purpose of getting a little information on this matter, I would like to ask Mr. Gillis if he could tell us by what method they decided that the taps were not up to standard. In

other words, if we go into the market and buy a tap from the maker which is supposed to be accurate, and I have no doubt that they have as good means as any one for determining that, are we to be at the mercy of the maker, or have we any methods for determining or proving whether the maker's tap is absolutely correct or not? For the purpose of gaining a little information, I would like to know that.

MR. GILLIS: The only way we have of determining is to take one of Pratt & Whitney's standard measuring machines furnished by them, which we think are fairly accurate, and then from that make a gauge and apply that to the taps. That is the way we determine.

MR. ROBERT MILLER: I am surprised at Mr. Manchester's remarks about broken stay bolts. That has not been our experience. We have taken our engines into the shop and tested them at 225 pounds to the square inch, twenty-five per cent above the allowed pressure, before the bolts were drilled. After drilling we have applied the same tests, and I can assure you that we have found twice as many stay bolts broken or cracked after they were drilled as we did in the first test. I am a little at a loss now to know whether his theory is correct.

MR. SOULE: I think the statement made by Mr. Gillis in his previous remarks ought to receive some further notice. That was that threads on the stay bolt could be cut by dies just as true to pitch without a lead screw as with a lead screw. I think that contradicts the general impression of most mechanics. In fact, I think the general impression is that if you do not have a lead screw you have got no guarantee whatever that the pitch will be true on a long stay bolt if cut by dies. If the relation between the diameter of the bar and the diameter of the dies, the way they are set, happens to be exactly right, you might get a stay bolt true to pitch. But the general impression which is abroad is to the effect that if the bar is oversized or undersized, you cannot get that correct pitch; that it will be either greater or less than what you intended, and if I am not mistaken a paper was read at the recent meeting of the American Society of Mechanical Engineers in which some specialist engaged in the manufacture of threading machines described some improvements in their construction, and in the course of his remarks he said openly, and it was accepted there without dispute, that it was not possible to get a correct thread, that is, correct as regards pitch, on a long bolt without the use of a lead screw.

MR. GILLIS: I would like to say in regard to that matter that I was of exactly the same opinion as Mr. Soule. I was going to say that is theoretically correct, but I will not say that, because your lead screw and your die would have to work in unison to be so. When we bought our machine I went to Baltimore with the intention of buying a lead screw machine, and they said they would as soon sell me a lead screw machine as not — just as much money or a little more in it for them — but from all their experiments they did not think it was at all necessary to have the lead screw. I saw a large number of stay bolts cut, 15, 18 and 20 inches long, with very perfect threads in them, as perfect as I ever saw cut on a lead screw. We are getting them now. Recently we had an inspector from the Swedish State Railway visit our works. One of the things he wanted to know was how we were cutting our stay bolts. I showed him. He thought we ought to have a lead screw. I said, let us cut some bolts. We cut some 18 and 20 inches long. He examined them almost microscopically, and decided that the bolts were plenty good enough for him. They tell me he is really one of the most rigid inspectors there are. He wanted the fire box measured with a micrometer gauge to see if it varied a thousandth part of an inch. It is needless to say we did not do that.

MR. T. R. BROWNE: In a long experience on that same line, probably three and a half to four years ago, we made the discovery that the taps we were getting from the manufacturers were apt to vary. Whether we were getting the first, second or third grade, I do not know. We found that to use a tap of that kind it was necessary to have some accurate method of measuring the variation, and we constructed a small machine for that purpose. We found, supporting Mr. Gillis' statement, that as much as half a thread in some cases in 8 to 10 inches would be the variation in the worst taps. Taking up the question we decided to make our own taps, and by a long series of experiments determined that a certain fixed grade of steel would change about a fixed amount in hardening. This amount we made allowance for, and by that means were able to secure taps whose variation in from 12 to 15 inches will hardly be more than from five to seven thousandths of an inch. Before we could do this, however, considering the question of lead screws in connection with the dies for threading with the dies being carefully maintained, we decided we would have one lead which was as near right as could be made, and that we would keep it for the purpose of correcting other screws, and

we would use that in making the hubs and the taps that were to be used in stay-bolt work. We do not use a lead screw in connection with our stay-bolt threading machine. It is of the Nicholson-Waterman type, if I recollect. The dies work vertically on guides. They are carried in carriers, and the work of these dies is carefully checked up at least once every day. For that purpose we provide the man who is running the machine with a gauge which very much resembles a saw, which is practically a thin slice cut out of a screw, by which you can detect any serious variations. The dies themselves are maintained by the method that I have mentioned. It will be obvious, of course, that we can provide a very close approximation to a standard plug for testing, and we find that the amount of variation that we get is not by any manner of means serious, and it does not in any case amount to the ordinary variation that will exist between the plates in a boiler by reason of their natural spring due to the process of tapping and handling generally in putting in the bolts.

In regard to the cutting off of the bolts and the screwing of them in, I would state that we have found it possible by means of a small hook gauge to average the length of those bolts and cut them off in the shop, not after they are screwed in the boiler, grouping them in such a way as to provide for the proper amount of riveting. We were led to do this because we found that in cutting off by the ordinary method, either by chisel or the machine which takes the place of the tool — in the case of the machine there is a tendency to spread at the end of the bolt, and in the process of riveting up, portions of that bolt which had no business to be upset, were upset. Our theory was that the bolt should be upset in the sheet from its center and not around its edges. We round off the end of the bolt to a radius which we have found to be satisfactory and which, with the least amount of hammering on the end, will properly cause it to fill up the thread in the sheet. For the purpose of screwing in these bolts, which we do, either from the inside or the outside, according to the angle at which they are with reference to the sheet, we have what might be called a stud nut, consisting of a sleeve tapped out in one end to suit the bolt, and beveled off so as to clear the angle that the sheet forms with reference to the bolt, and in this sleeve is a plug with a square end. Through the plug and the sleeve is a tapered pin fitting a hole in the plug, but which fits a slot in the sleeve, from which it is obvious that you can screw it tightly on the end of the bolt, taking up just enough threads to hold, and when you unscrew it, the plug will back

away, leaving the sleeve stationary until the pin is brought up against the slot in the sleeve, when the whole device can be unscrewed from the end of the bolt and used on the next bolt. Where the angle of the bolt in reference to the sheet is very great, frequently there is no thread on one side to get hold of the bolt. In cases of that kind we screw it in from the inside of the boiler. In reference to the Eccles taps, I would state that we carefully tried these taps alongside of brand-new taps of our own make on the same kind of work, compared them for resistance, compared them for the character of the threads that they cut and their length of life and clearance and wear due to chips, and found that after a period of about four months the taps of our own manufacture showed a better condition at the end of that time than the Eccles, which, I believe, is the one you referred to as a special tap in which every other thread is cut out.

MR. R. ATKINSON: I would like to put myself on record as not being a believer in drilling or punching stay bolts. It appears to me to be wrong in principle. The point where the stay bolts fail most is near the outside sheet, and at that point you take away some of the metal. We have tried some of them and the results are not satisfactory. They broke quite as frequently as a solid bolt, and it is rather misleading for any one to think that he could rely on getting a certain result from them when they would fill up with scale and leave him in the dark as to the condition of the box. Rather than be in that state of mind, we decided that we would do no more with them and rely entirely upon careful testing; that is, sounding with a hammer. But, of course, before doing that we went into the subject thoroughly, and found that we could get much better results by making the test while the boiler was under water pressure. Our standard now is that the boiler shall be filled to 150 pounds pressure, if that is the lowest working pressure, and hammered outside. If it is working at a pressure below that, then up to the pressure at which the boiler is working. We find that we can detect almost every broken stay bolt there is, and occasionally break off a few that are cracked in the process.

THE PRESIDENT: Gentlemen, time is going fast and we must close this up. Any gentleman who has heretofore spoken will not be allowed to speak on the question again.

MR. GAINES: In reply to Mr. Atkinson, I would say our experience has been contrary to what he states — that drilling a hole in the

stay bolt actually prolongs the life of the bolt. It seems to me that the stress is concentrated at the base of the bolt next to the sheet, and gives it longer life.

MR. QUEREAU: I recently came across a kink which may be of interest to some members who have not lead screws on their stay-bolt threading machines. It is the usual practice to upset both ends of the crown stays, and where there is no lead screw on the threading machine the threads on the two ends of the crown stay may be half a thread out. We generally correct this by putting the cold stay bolt, after it is threaded, on an anvil of a steam hammer and gently tapping it until the threads come true. It is very simple and very quick work.

MR. MORRIS: Mr. President, I move you that the discussion on the subject be closed.

The motion was carried.

THE PRESIDENT: Gentlemen, the next subject is the sixth, and if you will turn back to the noon topical discussion and find No. 3 there, I would like to consolidate these two under one head today in order to expedite matters. I will read the third of the noon topical discussions: "The best arrangement of flanged and bald tires on ten-wheel locomotives to secure the least wear of tires and rails." Now, No 6 is: "Is it desirable to have flanged tires on all the drivers of mogul ten-wheel and consolidation engines? If so, with what clearance should they be set?" Please consider now that we will take up both subjects. I hope, gentlemen, that in discussing this paper and all other papers this morning you will consider, unless you get special permission from the chair, that you will not speak twice on the same subject until all others have spoken, as per rule.

Mr. S. Higgins presented the following report:

REPORT OF COMMITTEE ON FLANGED TIRES.

"Is it desirable to have flanged tires on all the drivers of mogul, ten-wheel and consolidation engines? If so, with what clearance should they be set?"

To the President and Members of the
American Railway Master Mechanics' Association:

The desirability of using flanged tires on all the driving wheels of mogul, ten-wheel and consolidation engines depends on certain conditions which have to be taken into consideration, and these conditions are as follows:

1. Length of rigid wheel base.
2. Length of total wheel base.
3. Are rigid or swing-motion engine trucks used?
4. Lateral motion between driving box and hub, when engines leave shop.
5. Lateral motion between engine truck box and hub, when engines leave shop.
6. Degree of curvature on line where engines are to be operated.
7. Practice of Roadway Department as to the gauge used on curves.

In order to bring out these points, the committee issued a circular November 18, 1898, and a summary of the information received in reply to the circular is as follows:

Number of engines owned by roads answering circular.....12,265
Mogul..... 1,183
Ten-wheel..... 2,284
Consolidation..... 2,066

	All Flanged.	1 and 3 Flanged.	2 and 3 Flanged.	1 and 4 Flanged.	1, 3 and 4 Flanged.	Total.
Mogul.....	440	743	.....	.....	.....	1,183
Ten-wheel.....	534	1,048	702	.....	.....	2,284
Consolidation...	348	.....	.....	1,313	405	2,066
Total.....	1,322	1,791	702	1,313	405	5,533

	Longest Rigid Wheel Base.		Longest Total Wheel Base.	
	All Flanged.	Partly Flanged.	All Flanged.	Partly Flanged.
Mogul.....	16 ft. 1½ in.	16 ft.	23 ft.	23 ft. 10½ in.
Ten-wheel.....	14 " 4 "	16 "	24 " 10 in.	26 " 6 "
Consolidation....	16 " 3 "	16 " 3 in.	24 " 2 "	24 " 6 "

A swing motion engine truck is used with the three types of engines having all tires flanged, the motion being 1½ inches each side of center. The same practice prevails with mogul, consolidation and many ten-wheel engines having tires partly flanged, but about 50 per cent of the ten-wheel engines with tires partly flanged have rigid trucks. No matter whether engines of the types referred to have flanged tires on all driving wheels or not, the prevailing practice when such engines leave the shop is to have the lateral motion in each driving box ⅛ inch, and the same with each engine truck box. With tires partly flanged, the distance between backs of flanges for each type of engine covered by this report appears to be 4 feet, 5¼ inches.

In the case of engines having flanged tires on all driving wheels, the same practice prevails for mogul and ten-wheel engines. The prevailing practice with consolidation engines having flanged tires on all driving wheels is to have the distance between flanges on first and fourth pair of wheels 4 feet 5⅛ inches, and on the second and third pair of driving wheels 4 feet 5¼ inches.

The sharpest curvature reported from roads using all-flanged tires is 18 degrees.

The sharpest curvature reported from roads that use engines with driving wheels partly flanged is 16 degrees.

On a majority of roads that have replied to the circular, the track is laid wide of gauge on curves, but there does not appear to be any exact ratio between the degree of curvature and the amount that the gauge is widened.

The roads using flanged tires on all driving wheels, also the roads using flanged tires on a part of the driving wheels, report that their practice has not caused any trouble, and the benefits resulting from each practice are claimed to be as follows:

1. With flanged tires on all driving wheels:

Less flange wear, as the pressure between the flange and the rail is distributed more.

More uniform wear of flanges and driving wheel hubs.

As the tires wear down, the flange gives them greater strength, and there is less liability of thin tires slipping on center.

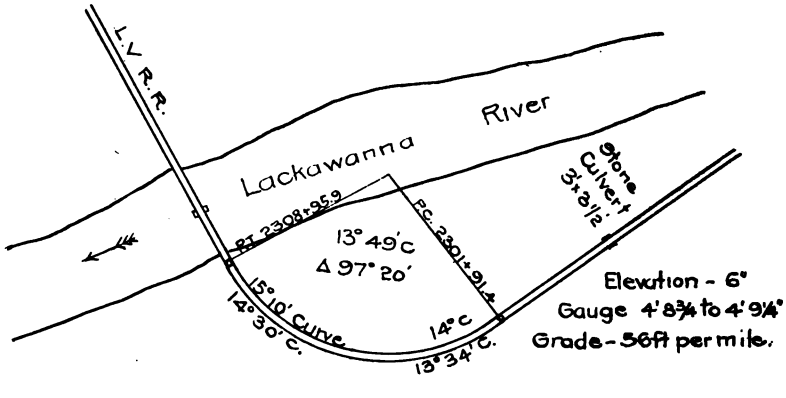
It is necessary to carry but one kind of tire and brake shoe in stock.

Engines ride better on curves and there are less derailments.

2. With flanged tires on a part of the driving wheels, it is claimed that there is less flange wear, engines curve easier, less liability of climbing the rail, less wear of rail heads. Less trouble with sharp flanges.

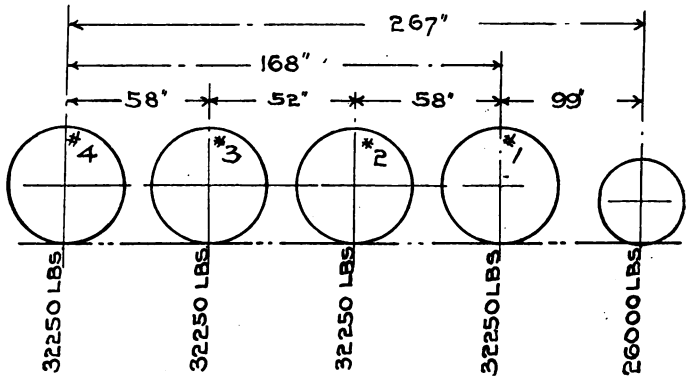
It will be seen from the above that the advantages claimed from each point of view are about the same, with the exception that the roads using flanged tires on all driving wheels have the advantage as to the variety of tire and brake shoes to be carried in stock, and as to the strength of the tire when reduced in thickness by wear.

In order to obtain information as to the resistance offered by a locomotive when passing through a sharp curve, the committee decided upon making some tests with a consolidation locomotive, assuming that that type of engine would represent the worst conditions. The tests were made on the tracks of the Lehigh Valley Railroad near Coxton, Pennsylvania, on a curve, as shown in the following sketch:



The engine with which the tests were made was of the consolidation type. The spacing of the wheels, weight on each pair of wheels, etc., are shown on drawing below:

WHEEL BASE ENG. 688



The engine was just out of the shop. Lateral motion in each driving box ⅛ inch. Lateral motion in each truck box $\frac{5}{8}$ inch. Swing motion engine truck; motion either side of center 1½ inch. Main rods and valve rods disconnected. Boiler full of water. The tests were made by hauling engine 688 through the curve at Coxton, entering the curve at the lower end, so as to have the grade to contend with, viz: 56 feet per mile.

The coupling between engine 688 and the engine that was used for moving engine 688 was made by means of a dynamometer furnished by Mr. Garstang, Superintendent Motive Power of the Big Four Railroad, and a drawing of the dynamometer will be found at the end of the report.

Three series of tests were made, the first test being made with flanged tires on first and fourth pair of wheels, plain tires on second and third pair of wheels.

The second test was made with flanged tires on first, third and fourth pair of wheels, plain tires on second pair of wheels.

The third test was made with flanged tires on all driving wheels. The tires used were new, Master Mechanics' Standard Section; width of flanged tires, 5¾ inches; width of plain tires, 6½ inches.

In tests 1 and 2 the flanged tires were located so that the distance between backs of flanges was 53¼ inches, while the distance between the inside of plain tires was 52½ inches.

In the third test the distance between flanged tires on first and fourth pair of wheels was 4 feet 5⅛ inches; on the second and third pair of wheels 4 feet 5¼ inches.

The plain tires were located on driving wheel centers, so that the center of the tread of the tire coincided with the center of the rail head on straight track.

In connecting the dynamometer between the two engines no springs were used, as the draw castings on each engine were bolted solid.

Several trips were made with each arrangement of flanged tires and plain tires, and readings were taken on each trip, while the engine was being pulled through the curve. A uniform speed of twenty-eight miles per hour was maintained during each trip, except the last trip of each test, when the speed was reduced to five miles per hour. A summary of the readings taken on the different trips is as follows:

TEST NO. 1.

Flanged tires, wheels 1 and 4.
Plain tires, wheels 2 and 3.
Distance between flanges, 4 feet 5¼ inches.
Distance between plain, 4 feet 4½ inches.

PULL ON DYNAMOMETER IN POUNDS.

Trip 1.	Trip 2.	Trip 3.	Trip 4.	Trip 5.
5,654.86	9,896.005	5,654.86	5,654.86	5,654.86
4,241.145	5,654.86	4,241.145	4,241.145	5,654.86
4,241.145	4,241.145	4,241.145	4,241.145	6,361.7175
	4,241.145	4,241.145		5,654.86
	4,241.145			4,948.0025
	4,241.145			5,654.86
				5,654.86
				4,948.0025
				4,948.0025
				5,654.86
				5,654.86
				6,361.7175
				6,361.7175
				5,654.86
				5,654.86
				6,361.7175
				6,361.7175
				6,361.7175
				6,361.7175
				6,361.7175
				6,361.7175
				6,361.7175
				7,068.575
				6,361.7175

TEST NO. 2.

Flanged tires, wheels 1, 3 and 4.
Plain tires, wheels 2.
Distance between flanges, 4 feet 5¼ inches.
Distance between plain, 4 feet 4½ inches.

PULL ON DYNAMOMETER IN POUNDS.

Trip 1.	Trip 2.	Trip 3.	Trip 4.
5,654.86	4,241.145	5,654.86	8,482.29
4,241.145	4,241.145	4,241.145	8,482.29
4.241.145	4,241.145	4,241.145	7,068.575
4,241.145	4,241.145	4,241.145	6,361.7175
4,241.145	4,241.145	4,241.145	6,361.7175
	4,241.145	4,241.145	6,361.7175
			5,654.86
			5.654.86
			5,654.86
			5,654.86
			6,361.7175
			5,654.86
			4,948.0025
			5,654.86
			5.654.86
			5,654 86
			5,654.86
			4,948.0025
			4,948.0025
			5,654.86
			6,361.7175
			5,654.86
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			7,068.575
			6,361.7175

TEST No. 3.

Flanged tires, wheels 1, 2, 3 and 4.
Distance between flanges 1 and 4, 4 feet 5⅛ inches.
Distance between flanges 2 and 3, 4 feet 5¼ inches.

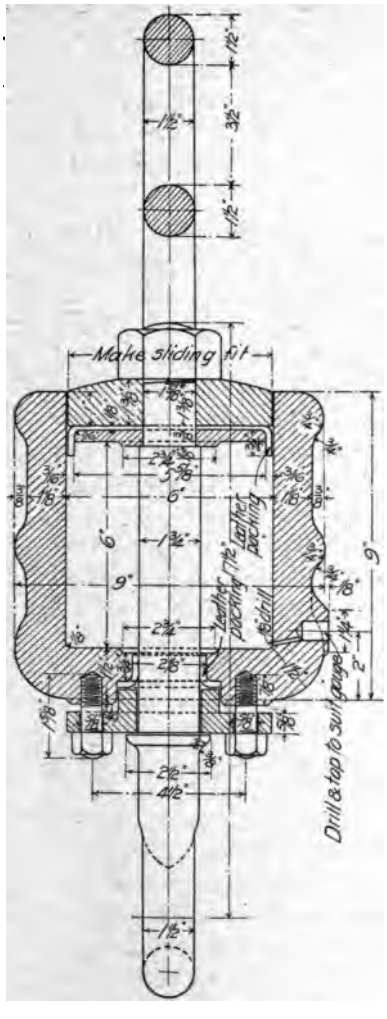
PULL ON DYNAMOMETER IN POUNDS.

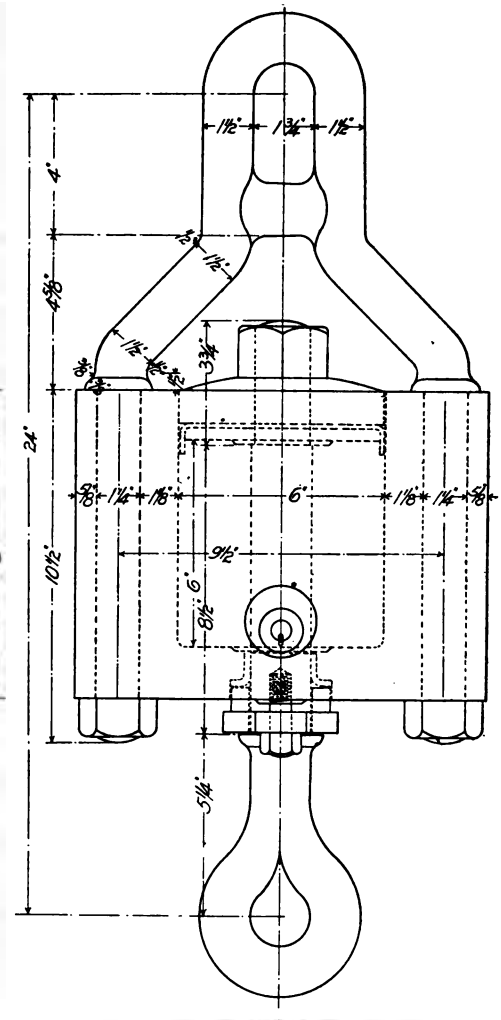
Trip 1.	Trip 2.	Trip 3.	Trip 4.
5,654.86	5,654.86	5,654.86	8,482.29
4,241.145	4,241.145	4,241.145	4,241.145
4,241.145	4,241.145	4,241.145	4,948.0025
4,241.145	4,241.145	4,241.145	4,948.0025
4,241.145	4,241.145	4,241.145	4,241.145
4,241.145	4,241.145	4,241.145	5,654.86
	4,241.145		6,361.7175
			6,361.7175
			5,654.86
			5,654.86
			5,654.86
			5,654.86
			5,654.86
			5,654.86
			6,361.7175
			4,948.0025
			5,654.86
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			6,361.7175
			7,068.575
			7,068.575
			7,068.575
			7,068.575
			6,361.7175
			6,361.7175

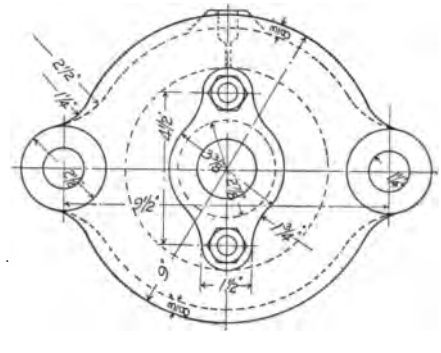
It will be noted from the readings that the power required to pull the engine through the curve with the different arrangement of tires is practically the same. The members of the committee are not prepared at this time to make any recommendation as to the desirability of using flanged tires on all driving wheels of mogul, ten-wheel and consolidation engines, but have presented all the information on the subject that they have been able to gather, and the committee now suggests the advisability of the investigation being continued, so that a final report can be made to the convention to be held in 1900.

If this is thought advisable by the Association, the committee would recommend the use of a self-registering dynamometer, and that tests should be made on straight track, as well as on a curve, an attachment to be used so as to indicate the lateral motion of the engine on straight track, at maximum speed, with the different tire arrangements.

S. HIGGINS, Chairman,
W. GARSTANG,
W. H. THOMAS,
Committee.


Make sliding fit
Leather packing 1/16" thick
Drill & tap to suit gauge





THE PRESIDENT: The paper is before you, gentlemen. What is your pleasure concerning it?

MR. HENDERSON: I move that it be received and opened for discussion.

The motion was carried.

MR. MCCONNELL: Mr. Chairman and Gentlemen,— In making inquiries on this subject I find that it is quite a common practice on the following roads to use flanged tires on switching engines, ten-wheelers, consolidation engines, six-wheel switching engines. A few of the roads at the bottom of the list have lately gone into it, but with the others the practice is quite common. The roads are: Rome, Watertown & Ogdensburg; Lehigh Valley; Delaware, Lackawanna & Western; Delaware & Hudson; Burlington & Missouri River; Southern Pacific; Oregon Railway & Navagation Company; Chicago & Western Indiana; Union Pacific; Kansas City, St. Joseph & Council Bluffs; and the St. Joseph & Grand Island. On the Union Pacific road for the past two years and a half, or I might say three years, it has been the common practice with us to apply nothing but flanged tires on our consolidation, ten-wheelers and switching engines. The consolidation engines are running on grades of ninety feet to the mile with maximum curves of ten degrees. Our switching engines in the yard are working through 22-degree curves. It is our practice on the consolidation engines to set the two middle wheels in — the two middle tires in — three-sixteenths of an inch closer than we do the front and the back tires. We follow the same practice on the ten-wheelers, and on the six-wheel switching engines. Our experience has been that we have less wear on the front and the back tires than we did when the two middle wheels on the consolidation and the middle wheel on the ten-wheeler were plain. The Burlington & Missouri River road purchased some consolidation engines last year for service on their Black Hills line. I believe they have grades there of three per cent and curves of over sixteen degrees. They found that the flanged tire on those engines were a little unsatisfactory, and they were obliged to change them, but on other portions of the road they give very satisfactory service. I understand that the Baldwin Locomotive Works and the Brooks Locomotive Works find this to be quite a common practice now for the roads ordering engines to have them equipped with all flanged tires. The Schenectady people and the Richmond people have not gone into this very

extensively, but the Schenectady people favor the application of the flanged tire on all classes of engines. The advantage, aside from the wear on the tire, is, as stated in the report of the committee, that it requires you to carry only one class of tire, and that is flanged tire. I would further state that on all of our engines as they come through the shop, where they have a blind tire, we are turning them up so as to build up a flange. On the engines having tires sufficiently thick before the tire is worn out, we have a new flange built up which gives us a flange on all of our tires.

THE PRESIDENT: I would like to inquire, Mr. McConnell, when you said you set your tires in three-sixteenths of an inch closer, is that a total of three-sixteenths of an inch?

MR. MCCONNELL: It is a total. Our rule is on the front and back wheels to give the tire five-eighths of an inch clearance; between the middle flanges on the two middle wheels, thirteen-sixteenths clearance.

THE PRESIDENT: As we have consolidated No. 3 of the noon topical discussions and this subject, I will ask Mr. Henderson to start the ball on topic No. 3.

MR. HENDERSON: When I first got the report of this committee on flanged tires in my hand I was in hopes that I would be let out of this part of it, but it seems that the tests show that the people who use all flanged tires are happy, and those who are not using flanged tires on all wheels are happy, so it is probable that I will get into a hornet's nest; therefore I will try and hedge a little so as not to stir up too much trouble for myself.

THE PRESIDENT: We don't want any hedging, Mr. Henderson.

MR. HENDERSON: The matter of ten-wheel engines is the principal point to which the topical discussion relates, whether they should have bald tires in front or not. Several years ago, on the Norfolk & Western road there were some ten-wheel passenger engines running with bald tires in front, and two or three arrangements with trucks having swinging or stationary centers were tried. On some parts of the road, where the curves were pretty sharp, we found that with rigid trucks there seemed to be a good deal of play when the engines struck a curve and a number of broken trains was the result. We then changed to swinging centers. They went around the curves easier, but there was a great deal of side motion. Finally, an elastic spring seemed to be the best arrangement of all; that is, we found

the engine would curve much more readily and the swaying motion would be almost absent, so that a truck with a spring to control a swing or free center hanger — that is, the hangers having two centers on top to return it very quickly — seemed to be the best arrangement. Those engines had bald tires in front altogether. I believe, though, lately there were some changes made and flanged tires were put in front. But it might be reasoned in this way: the American type of engines, that is the eight-wheeled type, has been run on a great many roads with swing-centered trucks and with flanges on the main wheels. A ten-wheel engine is not very different from the American type of engine with an additional pair of wheels put in. If we expect to do the guiding by the truck, the truck is farthest ahead, and it would seem that is the proper place to do the guiding. The truck being farthest ahead has a longer lever and would probably receive less resistance in pulling the engine than if we put flanges on the front pair of drivers. This is a matter on which there is a great deal of difference of opinion, and I merely presented it in that light in order to give a chance to the other members to discuss the point.

MR. PECK: I have been using flanges on all tires on six-wheeled switching engines for the past two years. The reason I did that was to save flanges. Frequently we would turn off three-quarters of an inch of tire on the front flanges in order to get good results.

MR. GILLIS: I want to say that the Richmond Locomotive Works are now up to date in regard to flanged tires. We received an order yesterday to put flanged tires on all the drivers of the Southern consolidation engines which we are building. While I say we are up to date, we are also about forty years behind the times, not exactly on consolidation engines, but on some of the ten-wheelers and moguls, for I remember in looking over an old catalogue of Rogers'— I think it is one of the oldest ones I have ever seen — they put their flanged tires on exactly as we are bringing it up now in this meeting, by setting the tires in — not having them all out at the same gauge. So there is nothing new under the sun. There are one or two questions in this report that I would like a little light on. It says lateral motion in driving box, one-eighth of an inch. Does that mean on each driving box, or does it mean on the axle? I know that we are increasing the lateral motion.

THE PRESIDENT: Can Mr. Higgins answer the question?

MR. HIGGINS: That means one-eighth of an inch on each box.

MR. GILLIS: I think that is right. I believe in lots of lateral motion on driving boxes, for if you do not give the box the lateral motion, it will take it. We had a lot of ten-wheel engines on the Erie road at one time that gave us endless trouble, running hot. We used to take them into the shop and take all lateral motion out of them down to the regular formula, which was one-sixteenth of an inch. I had one of them to take in at one time and the old foreman, who knew a great deal more about those things than I did, although I was supposed to be a better man than he was, said "Don't take up that lateral motion." I said "Why not?" He said "That engine will take it anyway and she will run hard until she gets it." So I did not take it up. We put the engine out in service and had no further trouble. So we think that lateral motion is a good thing on a journal. I would have liked to hear Mr. Henderson say something about his roller-bearing truck.

THE PRESIDENT: That is out of order, Mr. Gillis. Our time is short.

MR. GILLIS: Another matter is the varying wheel base. Is the putting in of the tires to be the same on all wheel bases? on the ten-wheel and mogul engines — whether this allowance between the back drivers and middle drivers is to be the same on all engines?

MR. HIGGINS: In regard to Mr. Gillis' question, I would state that the committee rather fixed a limit as to the wheel base of the consolidation engine on the basis that that would not exceed 17 feet; that is, the rigid wheel base. The committee is not yet ready to report as to the amount of clearance. That is a matter that we think should be gone into next year. The same applies on the ten-wheel engines with the shorter wheel base.

MR. DAVID BROWN: I am connected with one of the roads that are favoring flanged tires. We put flanged tires on all wheels. In answer to Question No. 3 here, as to the proper place for a blank tire, I would say in the scrap pile — it has no business on an engine, I believe. As regards consolidation engines we differ somewhat from the statement Mr. McConnell gives. We keep the tires on the inside axles the same distance apart; we reduce the flanges on consolidation engines — front and back — so that they have seven-eighths of an inch lateral play on the track. The second and third pairs of drivers have five-eighths of an inch lateral play on the track.

HE PRESIDENT: That corresponds with Mr. McConnell's statement.

MR. BROWN: Excuse me; I thought these middle wheels were closer; but we keep the wheel the same distance and we reduce the flanges on the consolidations, which is what I am speaking of now. By that means we have very good results. On the ten-wheel engines, we give seven-eighths in the front. We give them eleven-sixteenths on the main, and we give them half an inch on the back, lateral play on the rails. By that means we have very good results. We have an engine that came to us with a blind tire. The first time that that engine came in the shop to have her tires turned, there was merely the rut in the center of the tire caused by the wear of the rail, which was 6½ wide. We cut it down to the proper width, 5¾, which we used, and we left what we could of the flange. The second time, the same thing. Finally, there was a full flange on the tire. I have got some blue prints here showing what we give. It also shows that engine with the flange formed. In regard to play in the boxes, it is something similar to what the committee states. We taper our boxes very much on the inside though, top and bottom, leave about three inches in the center of the box, with the eighth of an inch beyond that, and allow the box to adapt itself to the wedges in curving. Our road is rather bad on that; we have a great many curves, and sharp ones.

MR. QUEREAU: Mr. Chairman, I move that this subject and committee be continued to report next year. In this connection I would like to suggest that we interest the track department in the subject. From some intimation I have had, which is not authoritative, but suggestive, I think it is possible that we will run into trouble on the frogs and switches by narrowing the gauge between the flanges on the drivers.

THE PRESIDENT: Won't you include in that that the subject be closed?

MR. QUEREAU: Very well, sir.

MR. WEST: I would like to ask, what is the use of continuing two such committees and then cutting off the discussion? We have had a report on stay bolts and a report on flanged tires. I believe half the members did not express themselves on the stay bolt question, and I know that half of them did not express themselves on this subject.

MR. SINCLAIR: We have always found it very objectionable to

carry over subjects to the next convention. There are three subjects already carried over, and when they come up the second time they are like sour milk. I have never seen a subject carried over yet but that it was a failure when it came before the Association the second time. I want to raise my voice against that indiscriminate way of carrying over the subject; it ought to be thoroughly discussed at the meeting, and if you want to continue it, discharge the committee and bring it in as a new subject.

MR. QUEREAU: Some people like sour milk. It seems to me we are just beginning to get at the gist of the subject. It is so important that we can not afford to drop it. We know that the individual Master Mechanics are not ready to carry it out.

THE PRESIDENT: It is a new thing; we have just commenced it and really it is a matter of theory with most of us. I know nothing about it. It seems to me we ought to have it in practice some time before we will know what the effects will be on certain other parts of the locomotive. As the committee has well said, it has made a certain recommendation for wheel base, but as to what the limits of play on the driving boxes ought to be it is not ready to report. Experience only will teach us that.

MR. R. P. C. SANDERSON: Before the discussion closes, there is one little thing I would like to call attention to. Assuming that the conditions under which the engines have to be run are such that either all-flanged wheels or bald tires can be used, it must be remembered that the flanged wheel on the outside of a curve is pressed against the box; the bald wheel on the inside of a curve is pressed against the box. Now, under those conditions it throws the rods out of line for all the slack that is in the boxes. I think, therefore, that a system of allowing freedom to the engine by putting slack in the boxes is not to be preferred as against the freedom furnished by allowing the clearance in the flanges of the wheels, so that the wheels can stay in line without throwing the rods out. That matter of rod repair and knuckle-joint repairs is very important on heavy engines, and that has a direct bearing on the point.

MR. ATKINSON: I have been studying this question for some time and I have ridden on engines that have had the leading driver tires set in. I did not feel satisfied at all with the manner in which they rode, as they had a swiveling motion. I have not ridden on any that have the driving tires set in to accommodate the curve,

and therefore I can not say how I should be satisfied with them. Up to date we have been putting a bald tire on the center of all our ten-wheel engines, and in the consolidation type usually two pairs of bald tires on the intermediate and the main drivers. I can only say that we are well satisfied with the manner in which the engines run and the effect upon the wheels. It is extremely rare to find a cut flange. On a question being raised by the road department some time ago, about the cutting of the inside rail on curves, it was attributed to the long wheel base of the engine. I immediately inspected about fifteen engines running over the section from which the complaint came. We found that the flanges of the tires were not cut. I therefore argued that the driving tire did not cut the rails. They said something cut it. I said, "Yes, and I guess I can find out what cut it." I found some trucks running over that division with their flanges cut. We later investigated the matter and found that wherever the curves were unduly widened the trucks of the freight cars and the trucks of the tenders were very liable to keep on in the tangent at which they entered the curve, and the outside leading wheel will cut slivers off the inside of the outer rail. I was led to that conclusion by seeing two small engines endeavor to haul twenty cars around a double 22-degree reverse curve. It was all they could do, and when they got through I found a sliver one-sixteenth of an inch long lying immediately inside of the outer rail. We stopped the train the next time on that curve and found the truck in the condition I have mentioned, with the leading wheel of the truck bearing so hard with its flange against the outer rail that it was cutting it. On measuring the gauge of the curve at that point, we found it was 4 feet 9¼ inches instead of 4 feet 8½ inches. So I recommended that in place of those engines a switching engine with a bald tire in the center, 10 feet wheel base, be put on, and the trouble ceased immediately. The gauge of the road was made 4 feet 8½ inches, and everything went around.

MR. G. W. WEST: The road with which I am connected has been using all flanged tires for eight years on all classes of engines—moguls, consolidations and ten-wheelers. When I went there, in 1890, we had ten moguls from which we could not get to exceed 10,000 miles out of the front drivers without renewing the flanges or the tire, and we began the practice suggested by Mr. Brown of just turning back, as the wheels came in for turning, as far as the flange would naturally be located, and before those engines had the

bald flange, we had no trouble with the cut flange in front. Since that we have purchased flanged tires for those engines, and the front flanges will run as long as any other flanges. We have no trouble with derailments. We have curves as high as fifteen degrees on our main line, and eighteen degrees in our mine work. The engines weigh 140,000 pounds, and we have no trouble whatever on that score.

THE PRESIDENT: We are glad to hear that, Mr. West.

MR. FRANK SLATER: With all due respect to what has been said by these gentlemen with regard to flanged tires on all wheels, I want to be put on record as saying that the easiest arrangement on truck and engine is one with a free-swing hanger and with the front and back tires flanged. If your engine is straight and is going around a curve, you have got to make room either in the tire flanges or in the driving boxes, and if you do not make it the engine will. If a rigid truck is to be used, a two-flanged tire should be put on the wheels that go closest to each other. In the case of a shallow fire-box engine, where the rear drivers are close together, the rear drivers should have the flanges, and the blind tire should be ahead. But on the deep fire-box engines, where the wheel base between the middle driver and the back driver is considerable, the front driver will be found the closest to the center of the truck. In that case the flange should be put on the front and back.

MR. LAWRENCE: Mr. McConnell in his opening remarks on this subject spoke of setting his tires in three-sixteenths of an inch. I would like to ask whether they have experienced any detrimental effects or whether any complaints have been received from the maintenance of way department concerning the guard rails.

MR. MCCONNELL: No, sir; we have never had any complaints from the track department in that direction.

MR. MANCHESTER: We have had a little experience with Atlantic type engines. So far as the flange of the wheel is concerned, it is practically a ten-wheeler. One lot of engines were put in service with the flanged tire on all wheels, set evenly on all the wheels. In order to make those engines run on the high-speed trains, it was necessary to give the driving boxes five-sixteenths of an inch on the main and five-eighths on the trailer wheels. Prior to doing this two of the trailing axles were sprung. The engines were never satisfactory riders. They always struck the curves hard until after they

were given this motion. Our experience with those engines has been such that today we are putting Atlantic type engines in service with bald main tire.

MR. ATKINSON: I would like to say, Mr. Chairman, that I am doing the same thing.

MR. HENDERSON: Was Mr. Quereau's motion seconded, Mr. President?

THE PRESIDENT: No, sir.

MR. HENDERSON: I will second that motion.

THE PRESIDENT: Mr. Soule, have you had any experience in this line. There has been a request for you to say something.

MR. SOULE: Mr. Chairman, I have not had much of any experience, and I have not had any settled convictions on this question. I have nothing to say in reference to it.

MR. MILLER: My attention was called to that very forcibly two and a half to three years ago. The practice at that time was to have a blind driver in front and a rigid truck. For certain reasons we knew that was wrong; we found out it was wrong and I changed them. In making the change I ran against the opinion of the chief engineer. I am strongly in favor of Mr. Quereau's motion that this be carried over another year. I do not think we have enough data on the subject. Our present practice is to have a bald tire in the center and two outside drivers and a swing motion truck.

The question was called for from the floor.

THE PRESIDENT: I do not know that the Chair has any right to entertain that motion now. It was not made a motion at the time and I think it will have to be repeated.

MR. QUEREAU: I move, Mr. Chairman, that this subject and committee be continued, and that they take into consideration and consult with the track department in respect to the influence of all flanged tires on the track. (Seconded.)

MR. BARR: I would like to ask in connection with that if all the gentlemen on the committee are full-fledged flanged tire men?

MR. HIGGINS: I am happy to say that there is only one full-flanged tire man on that committee, though I think Mr. Thomas is being converted.

THE PRESIDENT: All in favor of the motion will say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: That, then, will close the discussion on this subject for today. Relative to subject No. 7—"The best form of fire box to prevent cracking; is it advisable to use one piece for crown and side sheets?"—we have a communication here which the Secretary will kindly read.

MR. CLOUD read the following letter:

Mr. J. W. Cloud, Secretary American Railway Master Mechanics' Association, 974 Rookery Building, Chicago, Ill.:

DEAR SIR,—Owing to the very exacting duties that have been imposed upon me in my legitimate business, I have been unable to compile a report on "The Best Form of Fire Box," that would be satisfactory to myself or to the members of the Association. Neither have I been able to receive any great amount of assistance from other members of the committee, as I suppose their situation was similar to my own.

In view of these facts, I would respectfully recommend that the committee be continued for another year. I am sorry that I am compelled to make a request of this kind, as I had hoped that we would be able to make a very thorough and comprehensive report, but owing to the conditions arising, which I have no control of, I have been unable to do so, and would respectfully ask the indulgence of the Association in an extension of time, which I hope will enable us to make a thorough and exhaustive report. Yours truly,

H. MONKHOUSE,
Superintendent Machinery.

MR. MORRIS: I move we refer that report to the Executive Committee.

The motion was carried.

THE PRESIDENT: The next subject is No. 8: "The use of nickel steel in locomotive construction; its advantages and proper proportion of nickel." The chairman is Mr. Tracy Lyon, and he is not here. No member of the committee is here; Mr. Leeds and Mr. Mitchell are both absent. I will, therefore, ask that the Secretary read it in abstract or the conclusion.

MR. SINCLAIR: Mr. President, I am aware that Mr. L. R. Pomeroy supplied a good deal of the data for this paper, and I fancy he could give a synopsis.

THE PRESIDENT: If there is no objection, then that will be the order. Mr. Pomeroy will present the paper in such manner as he thinks best, as he knows considerable about it.

MR. POMEROY: As I understand this paper, Mr. President and gentlemen, it is simply a compilation or bibliography of the state of the art to date, as found in various publications, and does not give very much information, except in a general way, on the question of nickel steel. I was informed by the chairman of the committee that he did not commence his labors, owing to a misunderstanding, until very late in April, and it was too late then to gather much material, and his only idea was to make it the foundation for a subsequent report; that possibly these references might clear the way for the committee to make special investigation. I do not know whether it is the sense of the meeting that this should be read in that shape or not. What is your pleasure?

THE PRESIDENT: I think you had better use your judgment about that, and read such portions as you think would be of interest to us.

MR. POMEROY: I had not looked it over, so that if it meets your approval I will simply read it by title. You will see that the committee explains the situation on the first page, and the balance of it is devoted to extracts from material that is accessible to all of you, and is put in that shape simply to save you the time of going through it yourselves.

Following is the committee's report:

REPORT OF COMMITTEE ON THE USE OF NICKEL STEEL IN LOCOMOTIVE CONSTRUCTION.

To the President and Members of the
American Railway Master Mechanics' Association:

It is only fair to state that this report was not undertaken until late in April and that no more was proposed than to lay the foundation for the work of a future committee on "Nickel Steel."

This material was first brought into practical prominence at the time of the armor plate tests of the Government at Annapolis in 1890. It also came to be used by the Government for deck plates and stay bolts, but it was not until about 1896 that its use in this country began for locomotive construction; first in piston rods, crank pins and axles, and later in fire-box plates, side rods and stay bolts.

Up to this time, however, nickel steel has only been used in locomotive construction in an experimental way, judging from the answers received to the circular to members from this committee. Out of thirty replies, some twenty-five confessed to no experience at all with this metal, and most of the others stated that their experience had been too limited to enable them to give any information on the subject.

There follows some general information regarding nickel steel which has been

gathered from the best authorities within reach, both at home and abroad. It is not attempted to give a general history of the use and development of nickel steel, but rather to bring out the features of this alloy which are of practical interest to the members of this association.

Nickel steel is stated to be not a difficult alloy to manufacture, requiring no special furnaces, tools or thermal conditions. The cost of the nickel itself was, until 1875, $6.00 to $7.00 a pound, so high as to make its use for such a purpose impossible, but the opening in Canada of the most extensive nickel mines yet discovered has reduced the price to from 30 to 40 cents a pound.

Although nickel has been alloyed with steel in almost every proportion, what may now be called commercial nickel steel contains from 2 to 5 per cent of nickel. Such a material possesses great uniformity, the nickel being uniformly distributed throughout the ingot and not subject to segregation like other ingredients of steel, although some of the earlier experiments seemed to indicate a tendency, with more than 2½ per cent of nickel present, toward the formation in the heart of the ingot of long needle-shape crystals, which forging, hardening or annealing would not cause to disappear.

The addition of the nickel to steel adds particularly the qualities of toughness, durability and resistance to corrosion. Commercial nickel steel may possess the same elongation as ordinary steel with a tensile strength 30 per cent higher and an elastic limit at least 75 per cent higher (Wiggin, *Jour. I. & S. Institute*). This greater strength, and particularly the higher elastic limit, would appear to make its use for structural material, boilers and machinery, far more advantageous than ordinary steel, especially where a saving in weight is desired and the parts are subjected to alternating stresses.

With increased steam pressures, boiler plates two inches and more in thickness are demanded, bringing with them serious difficulties in handling and construction which it may be possible to obviate by using nickel steel plates 25 or 30 per cent thinner.

Most of the nickel steel made in this country contains about 3 per cent of nickel, and it is stated that such material can be worked without difficulty; rolled, forged, pressed in dies without cracking, flanged, punched, welded and machined. There seems to be no doubt, however, but that nickel steel cannot be machined as easily as low carbon steel. It takes the edge off tools very rapidly and the finishing cut is apt to sliver. The best of machinery and tools are required to cut a clean thread on stay bolts. One authority says that an alloy containing 1 per cent of nickel can be easily welded, but that with more nickel the difficulty of this operation increases. With more than 5 per cent of nickel all of these operations become considerably more difficult. A French authority states that it requires ten times more time to corrode a 5 per cent nickel steel when dipped in dilute muriatic acid than an ordinary soft steel containing 0.18 carbon. Other experiments, made by leaving planed plates exposed to the action of sea water for a year, showed a loss by corrosion of nickel steel plates of 1.36 per cent; of mild steel 1.72 per cent; wrought iron 1.89 per cent. A nickel steel has been offered for use for locomotive tanks on account of its non-corrosive qualities.

The Government specifications for the nickel steel propeller shafts of the U. S. S. Brooklyn required a tensile strength of 85,000 pounds and 50,000 pounds elastic

limit. The Navy appears to be using nickel steel very extensively now and provides the following general specifications covering its present use:

HIGH-GRADE MACHINERY FORGINGS.—To have a tensile strength of not less than 95,000 pounds, elastic limit not less than 65,000 pounds, elongation not less than 21 per cent in two inches. Oil-tempered and annealed. Used for main engine shafting, cross-head pins, connecting rods, piston rods, tie rods, valve stems, links, eccentric rods, etc., with their bolts, nuts, keys, feathers, etc.

CLASS A, NO. 1 MACHINERY FORGINGS.—To have a tensile strength of not less than 80,000 pounds, elastic limit not less than 50,000 pounds, elongation not less than 25 per cent in two inches. Oil-tempered and annealed or not, at option of manufacturer. Used for columns and other stationary parts of the main engines.

CLASS A, NO. 2 MACHINERY FORGINGS.—To have a tensile strength of not less than 80,000 pounds, elastic limit not less than 45,000 pounds, elongation not less than 26 per cent in two inches. Annealed only. Used for bolts or studs in flanges of steam cylinders, valve chests, steam and water pipes.

An ultimate resistance of 90,000 pounds can be obtained from 3 per cent nickel steel with very low carbon, say, 0.175, when to obtain this strength in ordinary steel would require at least 0.50 carbon, sufficient to make the material so brittle as to be unreliable. It is claimed that with the right treatment an ultimate resistance of as much as 135,000 pounds can be obtained with steel containing about 3 per cent of nickel (J. B. Nau, *Annales des Mines*). In general the elastic limit of nickel steel may be depended upon to be above 50 per cent of the ultimate resistance.

H. H. Campbell, in the *Journal of the Iron and Steel Institute*, gives the results of some tests of nickel steel as compared with other steels. The analyses are shown in Table I and the tests in Table II. Four tons of nickel steel were made, cast into two ingots and rolled to the various shapes mentioned.

TABLE I.

	C.	Mn.	S.	P.	Ni.
Nickel steel	0.24	0.78	0.027	0.027	3.25
Hard-forged steel .	0.30 to 0.35	0.60 to 1.00	0.03 to 0.05	0.03 to 0.05	....
Forging steel	0.25 to 0.30	0.60 to 0.80	0.03 to 0.07	0.03 to 0.06	....

TABLE II.

Shape.	Kind.	Ultimate strength. Lbs. per sq. in.	Elastic Limit.	Elastic Ratio. Per cent.	Elong. 8 in. Per cent.	Elong. 2 in. Per cent.	Red. Area.
Rounds a.....	Nickel	86,015	63,575	73.9	20.19	34.00	46.3
Rounds b.....	Hard forging.	87,663	58,055	66.2	16.70	24.44	30.3
Rounds c.....	Forging	78,066	51,793	66.3	23.94	24.44	52.0
Angles..... a	.....	86,960	58,553	67.3	21.75	39.66	50.5
Angles..... b	.....	87,820	54,153	61.7	19.25	34.83	43.3
Angles..... c	.....	76,970	49,544	64.4	19.25	34.83	49.6
Universal plates. Longitudinal .. a	.....	85,773	58,410	68.1	21.08	39.25	52.0
Universal plates. Longitudinal .. b	.....	82,773	50,163	60.6	20.50	37.67	47.0
Universal plates. Longitudinal .. c	.....	78,996	46,654	59.1	26.78	37.67	52.1
Universal plates Transverse.... a	.....	86,417	58,203	67.4	16.50	28.92	36.1
Universal plates Transverse.... b	.....	85,173	50,000	58.7	18.83	23.17	27.4
Universal plates Transverse.... c	.....	85,173	50,000	58.7	18.83	23.17	27.4
Sheared plates. Longitudinal.. a	.....	85,337	58,169	68.1	19.00	35 50	48.3
Sheared plates. Longitudinal.. b	.....	85,012	50,000	58.8	22.10	39.40	48.4
Sheared plates. Longitudinal.. c	.....	78,918	49,128	62.3	22.03	39.40	50.8
Sheared plates. Transverse.... a	.....	84,377	57,260	67.9	17.13	32.50	43.4
Sheared plates. Transverse.... b	.....	84,327	50,000	59.3	21.71	37.00	41.3
Sheared plates. Transverse.... c	.....	84,327	50,000	59.3	21.71	37.00	41.3

The result of a recent comparative test of nickel steel stay bolts as compared with iron is also given below:

Diameter.	Ultimate strength. Lbs. per square inch.	Elongation. Per cent.	Per Cent Reduction.
		Iron.	
.894	52250	8 inches 20.5 4 " 30.0 2 " 40.0	47.1
		Nickel Steel.	
.865	60560	8 inches 27.0 4 " 38.0 2 " 52.0	69.2

A prominent American manufacturer gives the following specification as proper for nickel steel parts of locomotives:

SPECIFICATIONS.

3 per cent Nickel Steel.	Minimum Tensile Strength.	Maximum Tensile Strength.	Minimum Elongation.	Elastic Limit.	
Crank pins	78,000	84,000	25% in 2 in.	½ of Ultimate	Oil-tempered.
Piston rods	78,000	84,000	25% in 2 in.	" "	
Driving axles	74,000	80,000	30% in 2 in.	" "	
Side rods	60,000	68,000	25% in 2 in.	" "	
Fire-box plates	60,000	68,000	20% in 8 in.	" "	
Stay bolts	58,000	66,000	20% in 8 in.	" "	

Maximum P. 0.03, S. 0.03, Mn. 0.40, C. 0.25, Si. 0.03.

From some experiments made in Belgium in 1894, comparing a ferro-nickel steel containing carbon 0.06 and nickel 7.5 and a high carbon steel containing carbon 0.55, the following general deductions as to the comparative results of hardening and tempering may be made. In the natural state the carbon steel was considerably superior to the ferro-nickel in point of limit of elasticity and ultimate resistance, but showed a much less elongation and contraction. When hardened in water at 900° or in oil, the ferro-nickel showed itself to be the superior at every point, still retaining a silky fracture, while the fracture of the hardened carbon steel was dry and granular. When annealed at 500° after hardening, the difference was not so marked, the carbon steel showing a greater ultimate resistance, but an inferiority in other respects. These tests show an ultimate resistance of the ferro-nickel of from 76,788 pounds per square inch in its natural state (elastic ratio 75 per cent) to 177,750 pounds when hardened in water (e. r. 85 per cent) and 141,631 pounds when hardened in oil (e. r. 97 per cent). The carbon steel showing 122,292 pounds (60 per cent), 104,943 pounds (72 per cent) and 132,815 pounds (76 per cent), respectively.

The results of quite exhaustive tests of nickel steel made by the St. Jacques Steel Works in France are of sufficient practical interest to be quoted here in full. These permit the classification of the metal into three different groups:

"1. Steels containing 2 to 5 per cent of nickel. Their resistance increases with the percentage of nickel, especially when the carbon content is low. When carbon reaches 0.50 per cent or more the presence of nickel has little influence. Steel of this class forges and rolls well. When hardened the ratio of elastic limit to ultimate resistance becomes very great.

"2. Steels containing from 10 to 20 per cent nickel. The resistance increases again with the amount of nickel. An addition of 0.10 per cent of carbon increases the ultimate resistance from 42,660 pounds to 92,430 pounds. Such steel containing 20 per cent nickel has a resistance of 156,420 pounds. If at the same time the carbon increases up to a certain limit, a resistance of more than 284,000 pounds can be obtained. The upper carbon content at which the resistance of a 10 per cent nickel steel begins to decrease again is 0.50 per cent.

"Steels of the second class do not harden much, and do not harden at all when the carbon is higher than 0.10 per cent. 20 per cent nickel steel never hardens. All are very brittle. They forge and roll well, but when containing more than 0.10 per cent carbon they cannot be machined.

"3. Steels containing from 20 to 25 per cent of nickel. Their elastic limit, as well as ultimate resistance, is low. They have great elongation, and are nearly free from brittleness. When forged at a low temperature without annealing, their elastic limit increases notably, and has reached 78,000 pounds, with an ultimate resistance of 113,700 pounds and an elongation of .25 per cent.

"With carbon content of less than 1 per cent the steel can be easily forged and rolled. Steel with 1 per cent of carbon can be forged between 500 and 1,000 degrees with light blows. Machining is difficult, but not impossible.

"From these tests it results that only the steels of the first and third classes can be used for practical purposes, the steels of the second class being too brittle and too difficult to machine." (A. Abraham in *Iron Age.*)

The suitability of nickel steel for tires is particularly mentioned. "The usual test of a tire is that it should stand compressing one-sixth of its diameter without cracking, but one of nickel steel stood compression from a diameter of 39½ to 19 inches without signs of fracture. A crack appearing in the metal does not develop as in carbon steel, and this renders it peculiarly applicable for shafts and axles." (W. Beardmore in *Jour. I. & S. Inst.*)

The experience of one of this committee with two piston rods of commercial nickel steel would confirm in a way this latter statement. After having been in service for two years, transverse cracks appeared extending over about one-third of the circumference of the rods and of a maximum depth of $\frac{3}{16}$ inches. When removed, however, the rods could not be broken with the heaviest sledges, one being finally fractured in a hydraulic press, while the other had to be drilled in two. These rods appeared to be soft, and the wearing surface did not glaze over, although no unusual wear of metallic packing was observable.

A user of nickel steel locomotive crank pins states that there seemed to be quite a variation in the hardness of different pins in the same lot, as evidenced by the behavior of the metal under the tool, and that the reduction in diameter of the softer pins under the pressure of the burnishing roll was particularly noticeable.

Another reports the trial of nickel steel bolts in place of iron (where the latter were failing and could not be made larger), but with no benefit.

A few members reported the recent use by them of nickel steel crank pins for locomotives, piston rods and fire boxes. Among the few comments made was one which referred to the rough appearance of nickel steel fire-box sheets, and another that it appeared, from a limited number of nickel steel piston rods in service, that they were more apt to break than those of ordinary steel. (No particulars given.)

It has not been attempted to touch on the use of nickel steel as a material for castings, but much may be looked for in that direction.

TRACY LYON,
P. LEEDS,
A. E. MITCHELL,
Committee.

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MR. BARR: Mr. Chairman, this is an interesting subject. It is one that we are not prepared to discuss. The report gives us a great deal of information and points out where further information is accessible. I move that this subject ——

THE PRESIDENT: Before you do that, Mr. Barr, let me say that I asked Mr. Porter, of the Bethlehem Steel Company, who is here, if he would contribute some data to this paper. I think he is as well posted on nickel steel as any man. If there is no objection from the floor to hearing him on this subject, I certainly would be glad to hear him and I think others would. (Applause.)

MR. SINCLAIR: I move that the report be received.

THE PRESIDENT: That is right. I am out of order, gentlemen. The motion is that the report be received and opened for discussion.

The motion was carried.

THE PRESIDENT: Mr. Porter, we will give you not to exceed five minutes. I think you can say a good deal in that time.

MR. H. F. J. PORTER: Mr. President and Gentlemen of the Master Mechanics' Association,—I am greatly honored by your request to say a few words on the subject matter of this report. I appreciate it particularly because I understand that it is contrary to your rules to admit to your floor any one connected with a manufacturing concern and not a member of your Association. You desire by this restriction, I presume, to prevent any attempt to advertise, and I assure you at the outset that I will endeavor to comply with your wishes in that regard. If, however, I should say anything tending toward that end, I beg that you will attribute it solely to a natural ebullition of pride, due to the fact that our company have been successful pioneers in the introduction of nickel steel into this country. If I transcend your rules, Mr. President, I hope that you will promptly call me to order.

My interest in this subject was first enlisted by your committee, who wrote to our company, and the latter referred the matter to me. I have had some correspondence with your committee and also with many of the roads to which our company has supplied nickel steel forgings for locomotive crank and cross-head pins, piston rods, axles, pedestal bolts, etc. For the reason, however, that these forgings have not been tested long enough to give comparative results I have not been able to receive satisfactory replies from any of these roads with reference to their service.

Your committee, I see by its report, has been equally unsuccessful in obtaining satisfactory information of this kind in reply to inquiries of a like nature. I have, however, in conversation with some of your members since I have been in attendance at your meeting, elicited considerable general information regarding the status of

the investigation by the railroads into the subject of nickel steel, all of which I think has a direct bearing upon the subject and it is with reference to this that I desire to say a few words. Let me preface my remarks, however, by a reference to something which Captain Evans said in his talk to you yesterday. You will remember that he spoke about the shock with which his request that steel be used in naval construction was received by the Naval Advisory Board, of which he was a member. "In 1882 I had the good fortune to be ordered as a member of what is known as the first advisory board for rebuilding the Navy. It was an awfully hot summer, and fifteen of us rather impatient spirits got together in Washington, presided over by Admiral John Rodgers. When we looked the field over, we found that we had no Navy at all; we were hopelessly behind the age, and it seemed hardly worth while to rebuild our Navy. I shall never forget, as long as I live, the trouble I caused in that small convention by proposing that we should build steel ships. I was the original steel man, and when I proposed that all ships in the future should be built of steel, Admiral Rodgers adjourned the board for three weeks to prevent a fight."

Now, what was the cause of the animus of that board which showed itself to be so unfavorable to Captain Evans' proposition? In order to understand the situation fully, let us for a moment consider the condition of the steel industry at that time. The large rolling mills of the country had just changed their product from wrought iron to steel, and manufacturers generally were beginning to learn that there was a new material in the market which was stronger and more to be depended upon than wrought iron. Up to this time, the industrial conditions of the country were such that there was no demand for forgings of any considerable size. The forges then in existence were equipped with small hammers which, by taking advantage of the property of welding possessed by wrought iron, were of sufficient capacity to build up such small forgings of that metal as were called for. As soon, however, as manufacturers knew that steel was being successfully made into rails, shapes, bars, etc., and understood how much stronger it was than wrought iron, they saw that by its adoption for forgings they could reduce the size of many parts of their machinery and at once made a demand upon the forges for forgings made of that metal.

Had the forges made modifications in their equipment to the same extent that the rolling mills had in order to meet the requirements of

the new material, without doubt satisfactory steel forgings could have been produced. Not appreciating the necessity of such changes, however, none were made, and such steel forgings as were produced were made under a totally inadequate understanding of the processes necessary for turning them out.

Wrought iron, as we know, is an elementary metal, always having about the same properties. It will stand considerable rough treatment in its process of manufacture, and as it possesses the property of welding, forgings of considerable size can be produced by building them up of small pieces under hammers of light weight. Steel, however, is a cast alloy, every cast producing a grade differing in composition more or less from other casts, and each grade of steel requires its own special treatment. Moreover, as steel of a grade from which forgings are made will not weld readily, and as a certain amount of work must be put into a casting to make it a forging, it is necessary to work down the finished piece from a block of steel of considerably larger size under hammers of larger capacity than those used for making the same sized wrought-iron forgings.

When, therefore, the manufacturers of the country called upon the forges for steel forgings, the forges did not have the necessary hammer equipment to make them, nor did they understand the delicate nature of the new material which they were expected to handle.

Many forges, however, did not hesitate to supply as good steel forgings as their ability and intelligence permitted, but these early attempts without adequate preparation were by no means successful, and the forgings then turned out were, as might have been expected, poor in quality and the results of their service were most disastrous. Thus, an undefined prejudice against steel forgings was engendered in the trades which exists to some extent among the misinformed even at the present day. It was this prejudice against steel which manifested itself in the minds of the advisory board which Captain Evans referred to, and it was very fortunate for the country that such a man as Captain Evans was on that board, and that he should have had the courage of his convictions to make the proposition and the pertinacity to bring about the final recommendation of the whole board that steel should be adopted as the material of construction for the new Navy.

Now, gentlemen, from what I have been able to gather from conversation with some of your members here during the last few days, I can see that a very similar condition of affairs is confronting us at

the present day with reference to nickel steel. You have been accustomed to use carbon steel for your forgings for several years and have gotten to know how to handle it, and your forges have gotten accustomed to making it for you. All this time, however, like intelligent men, you have been on the alert for something better. You have lately heard of the superior qualities of nickel steel, and supposing that you can get it readily you call upon the forges in general to supply you with nickel steel forgings. The forges, however, without equipping themselves properly for producing this new material, immediately supply something which they call "nickel steel" and which you are led to suppose is "nickel steel," but which is by no means *the* nickel steel under the technical acceptance of the term which has so deservedly won the enviable reputation for itself of being the strongest and toughest metal known.

Let me say a few words of explanation. Before this advisory board, of which Captain Evans was a member, made its final recommendation to Congress, its members went abroad to visit the great gun works and armor-plate works of Europe, and when they returned, the secretary of the board, Capt. W. H. Jacques, brought with him a proposition from Sir Joseph Whitworth & Co., of Manchester, England, to duplicate their forging plant, which was the most modern one in Europe for the manufacture of guns and miscellaneous forgings. This proposition, having been brought to the attention of our company, was accepted, and a few months later a contract was entered into between our company and the armor-plate forge of Schneider & Co., of Le Creusot, France, which was foremost at that time in the manufacture of that product.

Your report begins by saying that nickel steel was first brought into prominence at the time of the armor-plate tests of the Government at Annapolis in 1890. Those tests were made on armor plate made with the tools and equipment purchased from Whitworth and Schneider by our company, and from our experience with this metal, beginning before that time, we shortly afterward recommended its use for miscellaneous forgings, both for government and commercial work. For the manufacture of this material the greatest care has to be observed and special processes must be resorted to. It is cast under pressure to insure solidity and is worked into shape under hydraulic pressure. But of more importance than this special manipulation is the heat-treatment to which all such high-grade forgings must be submitted after manufacture, and every process must be accom-

panied by chemical, physical and microscopical tests to determine what this subsequent heat-treatment shall be.

On the top of the second page of your report it is stated that "nickel steel is not a difficult alloy to manufacture, requiring no special furnaces, tools or thermal conditions." This statement will stand considerable modification. The more we learn about steel, and nickel steel especially, we find that the thermal treatment has more to do with the development of its physical properties than had previously been supposed.

Let me give you an instance of what I mean. One of your members, who, by the way, is present here, asked me some weeks ago to let him have some nickel steel bars to test in his stay-bolt testing machine. I gave them to him, and after the lapse of some time he reported to me that they were the poorest rods he had ever tested. From my knowledge of the way in which nickel steel ought to have acted, I felt sure that the rods must have had some heat-treatment after leaving our hands, and I asked him to be kind enough to investigate. This he did, and found that the man in charge of the testing machine, not being able to cut threads on the rods, had tried to soften them by heating them. I asked the privilege of replacing the bars by others, all cut and threaded to fit his machine. These I furnished, and after a few days he reported that they had given better result than any other bars he had tested. It is this special treatment to which nickel steel must be subjected to bring out its high qualities that adds to its cost, and not the small amount of nickel in its composition. As far as treatment is concerned, there is just the difference between wrought iron and nickel steel that there is between the work horse and the racer, and yet it seems to me that those of you with whom I have talked expect that by buying racing stock and giving it the same treatment you would a work horse you will develop a racer.

I find that many of your roads and some of your locomotive works buy billets and blooms of nickel steel and forge them just as they would wrought iron. There are other roads which buy nickel steel forgings from forges who buy their billets and blooms and forge them into shape. But nickel steel forgings thus made are not the nickel steel forgings which have made their name prominent in the trades, and therefore I do not think they are what you are looking for to replace your carbon steel forgings. The nickel steel forgings which have made a reputation for themselves are those

which are made to meet the government specifications * mentioned at the top of page 3 of your report, and which have to pass government inspection before they are accepted, and these are what, I presume, you are looking for.

Until recently there was not a single forge in this country except ours that had fitted itself up for turning out forgings of this grade of steel. Within the past few months the forge next largest in the country to ours has prepared itself to turn out similar high-grade work.

You may ask how I know that some of the other forges can not turn out such a product by some other means than those adopted by ourselves and this other forge. My answer is, that until this other forge was equipped we received all the orders from the various shipyards about the country for these forgings for the United States Navy, although in several instances the orders were first placed with other forges, which after trial failed to produce them. Of late, however, owing to the fact that the Government has placed orders with the different shipyards of the country for very rapid delivery, under penalty, for four battleships, four monitors, sixteen torpedo boat destroyers and twelve torpedo boats, we have been compelled to decline orders for much of this navy work, as our capacity was greatly exceeded by orders already in hand. Our neighboring forge then prepared itself and has since taken those orders that we could not handle.

Now, gentlemen, I do not want you to think that I am endeavoring to solicit your orders for my company by these remarks. During the past fiscal year we have had gross receipts of several millions of dollars, but we have not received from all the railroads in the country orders amounting to as many thousand dollars. If you were to

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*The Navy appears to be using nickel steel very extensively now, and provides the following general specifications covering its present use:

HIGH-GRADE MACHINERY FORGINGS.—To have a tensile strength of not less than 95,000 pounds, elastic limit not less than 65,000 pounds, elongation not less than 21 per cent in two inches. Oil-tempered and annealed. Used for main engine shafting, cross-head pins, connecting rods, piston rods, tie rods, valve stems, links, eccentric rods, etc., with their bolts, nuts, keys, feathers, etc.

CLASS A, NO. 1 MACHINERY FORGINGS.—To have a tensile strength of not less than 80,000 pounds, elastic limit not less than 50,000 pounds, elongation not less than 25 per cent in two inches. Oil-tempered and annealed or not, at option of manufacturer. Used for columns and other stationary parts of the main engines.

CLASS A, NO. 2 MACHINERY FORGINGS.—To have a tensile strength of not less than 80,000 pounds, elastic limit not less than 45,000 pounds, elongation not less than 26 per cent in two inches. Annealed only. Used for bolts or studs in flanges of steam cylinders, valve chests, steam and water pipes.

increase your orders one hundred per cent, they would add very little to our income. We have made many thousands of nickel steel forgings of a general character, not only for the Government but for representative engineers who have wanted high-grade work; but they have been of a larger nature than those which we could hope to get from you, and these large forgings are what pay us to make and what we go to some trouble to secure. For instance, only last week we shipped to the Boston Elevated Railroad a shaft thirty-seven inches in diameter, twenty-seven feet ten inches long, with a seventeen-inch hole through it, made of fluid-compressed nickel steel, oil-tempered and annealed, weighing (with crank disks and pins and generator hub complete) 170,400 pounds, all to meet specifications similar to those required by the Government. For this shaft we received more money than we received last year from all the railroads in the country put together. Orders of this kind are what we are anxious to obtain, and put ourselves to some trouble to solicit.

Now, I do not wish you to think that I desire to injure our competitors by adverse comparisons. I feel that if you are fully advised of the situation you will draw up your specifications and see that your requirements are adhered to by inspection, and then the forges in general will equip themselves to meet your needs. We do not fear competition, but we want intelligent and fair competition. It has been said that our prices are high compared with those asked by other forges. As I have already explained, the extra price for nickel steel forgings comes not from the amount of nickel in the material, but from its treatment in manufacture. *On the same specifications* our prices will be lower than our competitors' owing to our superior equipment and facilities.

My sole desire in placing the situation before you as I have done is to prevent, through your assistance, the possibility of nickel steel receiving a "black eye," as carbon steel did in the days of Captain Evans' advisory board. I have had several evidences of the proximity of such an occurrence brought to my attention by your members of late. Let me give you one of them.

Several weeks ago two of your members called at our works and said that they had been trying some of our nickel-steel forgings on their locomotives with excellent results, but that since they had left home they had called on the Superintendent of Motive Power of an Eastern road, who told them that he had been buying nickel-steel piston rods from us for some time and that he had had a greater mor-

tality in piston rods since then than ever before. Of course, we immediately began to look into the matter, for we felt sure from our previous knowledge of nickel steel that there was a mistake somewhere. When we first met the Superintendent of Motive Power above mentioned, he said he had lost some thirty-five or forty of our rods during the past year. When we showed him that we had sold him only twelve piston rods, his interest was aroused; and on looking into the matter further he found that not one of our rods had broken in service, and that only one rod was out of use and that was owing to its having been damaged in some way while fitting for use. The broken rods had been furnished by another forge. Reference to this is made in the last sentence of the next to the last paragraph of your report.

Probably in this instance the matter had been left to the Purchasing Agent, whose duty it was, without further instructions, to buy the rods where he could get them cheapest. I have noticed, since I have been here, a tendency to refer such matters to your Purchasing Agents. This is perfectly right when you are satisfied that a material is standard or is ordered under specifications and inspection, but until then it would be better to keep the directions as to purchase in your own hands.

Our company will be very glad to aid your Association to the full extent of its ability, either through its individual members or through an authorized committee. Our works are, as you may know, closed to the public, but I will offer, on the part of our company, to open them to any representative Superintendent of Motive Power or Master Mechanic who will visit them with the full intention of looking into the subject for his road. We will also open them to your committee and supply to the latter test bars made according to government specifications or according to such specifications as after a full understanding of your requirements we can mutually agree upon.

Finally, we will offer to make for a limited time — say, for a month or until the end of July — forgings of nickel steel according to such recommendations as our past experience would dictate, at a reduced price, provided that you will keep a careful record of the service of these forgings, and, when they break, return them to us with a full report upon them. I make these offers in order that we may give you the benefit of years of experience and start

you off where we are now, and then, working along with you, help you to obtain what you are looking for at the earliest possible moment.

I am very much obliged to you, Mr. President, for according to me the privilege of the floor, and, gentlemen, I thank you all for your attention and trust that I have not wearied you with my desultory remarks. (Applause.)

THE PRESIDENT: Is Mr. Anderson, of the Carbon Steel Company, here?

Mr. Anderson did not respond.

THE PRESIDENT: Mr. Barr has the floor.

MR. BARR: Mr. Chairman, I move that the report of the committee be printed in our proceedings as a matter of information, and that a discussion of the same be postponed.

The motion was carried.

THE PRESIDENT: Our next subject, No. 9, is: "Standard Pipe Fittings."

The committee on this subject, through its chairman, Mr. Quereau, submitted the following report:

REPORT OF COMMITTEE ON SQUARE HEAD BOLTS AND NUTS: STANDARDS FOR PIPE FITTINGS.

To the President and Members of the
American Railway Master Mechanics' Association:

STANDARD THREADS FOR WROUGHT IRON PIPES.

That our recommendation may be intelligently acted on, it has seemed best to give in outline the history of the present standard known as the Briggs, condensed from the report of the Committee on Standard Pipe and Pipe Threads of the American Society of Mechanical Engineers, presented at their seventh annual meeting, New York City, November 29 to December 3, 1886.

At a meeting of the American Society of Mechanical Engineers, held in Boston in November, 1885, a committee was appointed by its President to co-operate with the manufacturers of pipe, pipe dies and fittings, with the object of securing uniformity in the sizes and threads, and of maintaining these by the use of standard gauges. Previous to this action of the American Society of Mechanical Engineers, the pipe manufacturers of the United States had nominally adopted the Briggs standard, but a comparison of their products had shown variations which prevented a perfect interchange. A joint meeting of the committee appointed by the American Society of Mechanical Engineers and one appointed by the Manufacturers of Wrought Iron Pipe and Boiler Tubes in the United States was held in New York City, June 17, 1886. At this meeting a motion was carried unanimously "that each manufacturer send to

The Pratt & Whitney Co., Hartford, Conn., sample pieces of their pipe from six inches diameter down, threaded on one end, to be tested by the Pratt & Whitney Co. with the Briggs standard, and a report to be made by them to each manufacturer of the state of his gauges only, as compared with the Briggs standard." As a result, samples were received by The Pratt & Whitney Co. from —

The National Tube Works Co.	Crane Brothers Manufacturing Co.
Reading Iron Works.	Morris, Tasker & Co.
A. M. Byers & Co.	Fieldhouse, Dutcher & Belden.
Spang, Chalfant & Co.	The Allison Manufacturing Co.
American Tube and Iron Co.	James Hooven & Son.
Cohoes Tube Works.	Delaware Iron Co.
Conshohocken Tube Co.	The Pittsburg Tube Co.

The gauges used by the Pratt & Whitney Co. were made by them from an autograph copy of a table made by Mr. Robert Briggs personally, who originally established and published what is known as the Briggs standard wrought iron pipe threads, a copy of which follows:

STANDARD DIMENSIONS OF WROUGHT IRON WELDED TUBES. BRIGGS STANDARD.

Diameter of Tube.			Thickness of metal.	Screwed Ends.	
Nominal Inside.	Actual Inside.	Actual outside.		Number of threads per inch.	Length of perfect screw.
Inches.	Inches.	Inches.	Inch.	No.	Inch.
⅛	0.270	0.405	0.068	27	0.19
¼	0.364	0.540	0.088	18	0.29
⅜	0.494	0.675	0.091	18	0.30
½	0.623	0.840	0.109	14	0.39
¾	0.824	1.050	0.113	14	0.4c
1	1.048	1.315	0.134	11½	0.51
1¼	1.380	1.660	0.140	11½	0.54
1½	1.610	1.900	0.145	11½	0.55
2	2.067	2.375	0.154	11½	0.58
2½	2.468	2.875	0.204	8	0.89
3	3.067	3.500	0.217	8	0.95
3½	3.548	4.000	0.226	8	1.00
4	4.026	4.500	0.237	8	1.05
4½	4.508	5.000	0.246	8	1.10
5	5.045	5.563	0.259	8	1.16
6	6.065	6.625	0.280	8	1.26
7	7.023	7.625	0.301	8	1.36
8	7.982	8.625	0.322	8	1.46
9	9.000	9.688	0.344	8	1.57
10	10.019	10.750	0.366	8	1.68

Taper of conical tube ends, 1 in 32 to axis of tube. (¾-inch per foot.)

By the late action of the Manufacturers of Wrought Iron Pipe, 9-inch outside diameter has been excepted from the original list, as above noted, the diameter now adopted being 9.625 instead of 9.688 inches given in the Briggs table.

As a result of the examination of the samples submitted, it was found that the variations from the original standard were such as to warrant the conclusion that the

Briggs standard should be maintained. With the exception of the ¾-inch and 1-inch sizes, comparatively little change would be required in any of the dies to accomplish this.

At a meeting of the Manufacturers of Wrought Iron Pipe and Boiler Tubes in the United States, held in Pittsburg, November 4, 1886, the following motion prevailed:

"*Resolved*, That the Wrought Iron Pipe Manufacturers of the United States hereby adopt the Briggs standard of gauges, and that where any manufacturer has from any cause got away from the standard, they be requested to get such corrections made as soon as possible, so as to conform to the Briggs standard."

A meeting of the Manufacturers' Association of Brass and Iron, Steam, Gas and Water Work, was held in New York City, December 15, 1886, at which meeting the following resolution was passed:

"That the action of the Wrought Iron Pipe Association in adopting the Briggs standard as the standard iron pipe gauge of the United States be indorsed, and that as manufacturers of brass and iron, steam, gas and water work, we will act in conformity with the resolution adopted by them."

In view of what has preceded, it seems to be well established that it was the intention to adopt the Briggs standard of threads for wrought iron pipes and fittings.

From what has preceded, we believe we are justified in concluding that the various associations passing the resolutions quoted intended to adopt the Briggs standard threads as determined by the gauges made by the Pratt & Whitney Co., from the autograph tables of Mr. Briggs.

Notwithstanding the action taken by the Manufacturers of Wrought Iron Pipes and Boiler Tubes and Pipe Fittings, as outlined above, recent investigations made by your committee disclose the fact that so far as the ¾-inch and 1-inch sizes of pipes are concerned, certain manufacturers are still adhering to the standards they had in use in 1886. The variation from the Briggs standard in these sizes of pipes is due to the fact that some makers use a thicker wall by using a larger outside diameter than called for by the Briggs tables, this difference averaging about .03 of an inch. As a consequence the couplings of these thicker pipes are somewhat large for pipes made in accordance with the Pratt & Whitney Briggs standard, and the pipes themselves somewhat large for the couplings made to the Briggs standard.

From the answers received to the circular letter sent out by the American Railway Master Mechanics' Association Committee we draw the conclusion that very little trouble is experienced because of lack of uniformity in the threads of wrought iron pipes and couplings; that there is a general understanding that the Briggs table of threads and dimensions is the adopted standard. Out of about sixty replies to this circular we find but eight roads which specify by what templates the Briggs standard shall be tested, and of these eight, six specify the Pratt & Whitney Co. templates.

In view of the foregoing facts we recommend the adoption of the Briggs standard, as determined by the Pratt & Whitney Co. gauges, as the standard threads for wrought iron pipe and couplings.

STANDARD THREADS FOR WROUGHT IRON PIPE UNIONS.

So far as we have been able to determine, there is no universal standard for the threads of wrought iron pipe union nuts, though the sleeves of the unions are quite

generally threaded in accordance with the Briggs standard. Because of the great number of standards used by the different manufacturers, the number of changes made in the chairmen of the committees, the lack of promptness in receiving promised samples, and several other causes producing unavoidable delays, we are unable to make any recommendation concerning Standard Threads for Wrought Iron Pipe Unions at present. We believe it would be wise if such a general standard could be adopted and would recommend that this portion of the work be continued.

C. H. QUEREAU, Chairman,
W. H. MARSHALL,
H. MONKHOUSE,
Committee.

The report of the above committee was approved by the Committee American Society of Engineers, at its meeting in Washington, D. C., May, 1899. The report on Square Head Bolts and Nuts is as follows:

REPORT OF COMMITTEE ON SQUARE BOLT HEADS AND NUTS.

To the President and Members of the Master Car Builders' Association:

Your Committee on Square Bolt Heads and Nuts sent out the following circular of inquiry, and replies were received from twenty-five roads and one car builder. Copies of circular were sent to the car builders for the purpose of ascertaining what standard they followed.

CIRCULAR.

"1. Do you make the square-headed bolts used on your line?

"2. If you make them, what standard do you follow as regards size and thickness of head?

"3. If you make them according to M. C. B. or Sellers' Standard (see pages 378, 379, 1898 report), do you find any difficulty in procuring a perfect head at one operation of the bolt-header?

"4. When purchasing square-headed bolts, do you specify any standard for head?

"5. Have you ever found any objections on the part of the manufacturers to furnishing bolts with Sellers' standard head? If so, please state objections.

"6. Do you find from any evidence from service that the heads are not large or thick enough.

"7. Please give thickness and size of square heads from ¼ inch to 2 inches diameter."

The replies to circular show as follows:

SQUARE BOLT HEADS.

1. Sixteen roads make their own bolts. Seven roads do not make their own bolts.

2. Fifteen roads follow M. C. B. standard. One road follows Manufacturers' standard (so-called).

3. Twelve roads do not find any difficulty in making bolt heads M. C. B. standard. Two roads find difficulty, as they have to take two heats and go through two operations of the machine.

4. Five roads specify standards. Eight roads make no specifications.

5. Eleven roads have found no objections on part of manufacturers to furnishing bolt heads to M. C. B. standard. Two roads have found such objections.

6. Twenty roads find no evidence that heads are not strong enough.

7. Fourteen roads give M. C. B. standard. Three roads give so-called Manufacturers' standard.

One car builder says they make their own bolt heads, M. C. B. standard.

One road — one of the largest systems — writes as follows: "The principal objection we have experienced was that when orders were placed with manufacturers for U. S. standard headed bolts we were informed that it would be necessary for them to make special dies for making heads. Formerly we endeavored to adhere to the U. S. standard head, but in order to get competition, as nearly all bolt manufacturers were using Manufacturers' standard head and never having had any trouble with their heads parting from the body of bolt, it was decided that it would be advantageous to use a size that could be purchased in the open market."

It is to be regretted that so few members replied to the circular, as the majority of replies are from large systems who manufacture their own bolts, and it is believed that had more of the smaller lines replied it would have shown that a large proportion of them purchase their bolts. It will be seen that of twenty-five roads replying to circular, sixteen make their own bolts, fifteen make them according to M. C. B. standard, and twelve state they have no difficulty in making them to M. C. B. standard.

In view of this statement, it would seem strange that there are so many different size bolt-heads in service, and this can only be accounted for, we believe, by car builders not following, and smaller roads not purchasing, M. C. B. standards.

CIRCULAR CONTINUED.

PART II.

"1. Do you make or purchase square nuts used on your line?

"2. What standard do you follow in the manufacture of square nuts?

"3. Do you specify any standard? If so, what one, when purchasing square nuts?

"4. Do you find any difficulty in obtaining square nuts according to Sellers' standard?

"5. Please give the thickness and size of square nuts from ¼ inch to 2 inches which you make or use."

The above circular relative to nuts was sent out and replies received from twenty-five roads as follows:

SQUARE NUTS.

1. Twenty-five roads purchase all their nuts.

2. No answers.

3. Twenty roads specify M. C. B., U. S. or Sellers' standard, two roads make no specification as to size, one road specifies Manufacturers' standard.

One road gives their sizes for nuts from ¼ to 1¼ inches, which show that for hot-pressed nuts they do not follow M. C. B. standard except for ¾ and 1-inch nuts; the dimensions for these sizes are M. C. B. standard. No explanation was given as to why this practice is followed. For cold-pressed nuts they have dimensions not M. C. B. standard.

One road gives sizes for nuts used on their system from ⅜ to 1¼ inches, and they are all M. C. B. standard except ⅜ and ⅞ inch.

In outlining the work of this committee it was thought best to work jointly with a committee from the American Mechanical Engineers' Society, and the Bolt Manufacturers. We were not successful in getting the American Mechanical Engineers' Society to take up the subject, but succeeded in getting the Bolt Manufacturers to do so and they appointed a committee for that purpose. The subject was taken up with individual members of the Manufacturers' committee, and all claimed that they should have to charge from ten to fifteen per cent more for bolts made with M. C. B. heads than for those with Manufacturers' heads, on account of the increased amount of metal in the head and the extra labor and time consumed in making them, and in changing dies. It was also claimed that there was very little call for bolts with M. C. B. or U. S. standard heads, but that the Manufacturers' standard was just as strong and serviceable and answered all requirements.

In order to determine whether or not this was true it was thought advisable to arrange for a comparative test of both standards.

This test was made at Purdue University, through kindness of Professors Goss and Hatt, to whom the thanks of the Association should be extended. It is a valuable report and the only one of its kind that has ever been made.

The Manufacturers kindly consented to furnish bolts with M. C. B. standard heads and bolts with Manufacturers' standard heads. It must be understood that these were to be made as near these standards as a rough bolt or forging could be.

Herewith you will find report of test made, also a letter of explanation from Professor Hatt.

REPORT ON COMPARATIVE TEST OF BOLT HEADS,

By W. Kendrick Hatt,

Associate Professor of Applied Mechanics, Purdue University.

Prepared for Mr. B. Haskell,

Superintendent Motive Power, Chicago & West Michigan Railway.

The following tests were made in the Engineering Laboratory of Purdue University during the winter of 1899 by Mr. Arthur Dufty and Mr. J. J. Wiselogel, senior students in mechanical engineering, working under the immediate direction of Prof. W. F. M. Goss and the writer.

PURPOSE OF TESTS.

The tests were undertaken at the request of Mr. Haskell, chairman of committee of the Master Car Builders' Association, to report on the proper size of bolt heads. The position had been taken by the manufacturers that the large head called for in the U. S. standard involved the upsetting of so large a mass of metal that two blows were necessary to perform the work. Consequently the proper degree of heat could not be maintained during the operation and the resulting bolt head was thus weaker than would be the smaller head, known as the Manufacturers' standard head. The tests which follow seem to justify this position.

The sizes of the heads will be found in detail in Tables A to I.

The committee contemplated testing bolts from eight different manufacturers. However, bolts were received from only five companies. One of these five sent only one standard, the Manufacturers' standard, and so the tests on these bolts yield no comparison.

There were received from each of the four makers bolts ranging in size from ¼ to 1¼ inches in diameter, advancing by eighths. Each size was represented by eight bolts; four of each were Manufacturers' standard and four were U. S. standard; thus comparative data has been obtained from 288 bolts.

The quality of the iron in the different lots of bolts was markedly different, so that nearly all the bolts of one lot broke in the head and nearly all of another lot broke in the body. The quality of the iron is indicated below.

QUALITY OF METAL.

No. 1.— A good quality of gray iron of close texture. Tensile strength, 46,000. Elastic limit, 32,000. Percent of elongation = 5.0.

No. 2.— An excellent iron, with considerable contraction at breaking. Tensile strength, 47,000. Elastic limit, 42,000. Percent of elongation = 22.0.

No. 3.— A fair iron, with seams, and black appearance; shows fine fiber. Tensile strength, 51,000. Elastic limit, 33,000. Percent of elongation = 4.4.

No. 4.— Poor iron, with crystallizations and black areas. Tensile strength, 55,000. Elastic limit, 37,000. Percent of elongation = 8.7.

No. 5.—Steel bolts, except 1¼ and 1⅛ inch. Steel — tensile strength, 59,000. Elastic limit, 37,872. Percent of elongation = 28.1.

Elongations are in percent measured in 8 inches. Tensile strength and elastic limit in pounds per square inch. Elastic limit was obtained by noting the drop in the scale beam.

TESTS.

The bolts were stamped with consecutive numbers and proper logs prepared.

It was decided to use two kinds of test.

TENSION TEST.—The first test was a straight tension test in which the bolt was let through a hole bored to an easy fit in an 8 by 10 by 1½ inch steel plate, allowing the head to bear directly on top of the 100,000-pound Olsen testing machine. The shank of the bolt was gripped in the wedges of the lower moving head of the machine, and load applied with a speed of 0.35 inches per minute. The load at elastic limit (yield point) and that at failure was noted. Failure occurred either by the bolt stretching and finally breaking in the shank of body, or else by the head pulling off. Two bolts of each make, diameter and standard were tested in the tension test just noted.

ECCENTRIC TEST.—It was thought that any weakness at the joint between the shank and head of the bolt could be developed and made evident by a strain which would tend to open up this joint. After a trial of several methods it was found best to use the bolt as in the tension test, Plate 1, except that, instead of allowing the head to bear directly on the steel plate, an eccentric bearing for the head was introduced, as shown in Plate 2. Block "A" is a hardened steel plate with a semi-circular opening in the side which fits around the shank of the bolt. "C" is a wedge of hardened steel which rests against the shank of the bolt, and serves to keep the latter straight while the bolt head rotates. Thus, when load is applied to the shank of the bolt, the action of the hardened steel block "A" is to produce rotation of the head until the latter comes to bearing on the steel wedge "C." The load can then be measured at which the head breaks off, without any error due to friction of the body of the bolt in the hole of the main bearing plate.

RESULTS.

TENSION TESTS.—The tension-test logs for each make of bolt are collected together in Tables A to D inclusive, in which, following the test numbers, are shown the measured diameter and the load at failure for both standards.

ECCENTRIC TESTS.—The same measurements are given for eccentric tests in Tables E to H inclusive. In Table I is given an intercomparison of the results on two standards, while in Tables J and K the comparisons between the standards are made with reference to the tensile strength of the body of the bolt. That is, the strength of the head is shown in percent of the strength of the shank. These comparisons are shown more clearly in the graphic curves.

DISCUSSION OF RESULTS.

From Table I it will be seen that the Manufacturers' standard has the advantage over the U. S. standard when a comparison is made of the number of times the head pulled off as against the number of times the bolt broke in the body. Thus, in the tension test the percentage of the U. S. standard bolts breaking in the body was 31.9, and the percentage of the Manufacturers' standard breaking in the body was 48.7. In case of the eccentric test, the percentage of U. S. standard breaking in the body

was 19.4, while the percentage of Manufacturers' standard breaking in the body was 27.7. An examination of the individual results all confirm the indication of the average.

A comparison is also possible of the relative strength against the pulling off the head for those tests in which the head did pull off. The column giving the number of times the U. S. standard was stronger than the Manufacturers' when the head pulled off, may be compared to the column giving the same facts when the Manufacturers' head pulled off. It will be seen, comparing the loads at failure of the head, that although a greater number of the standard heads pulled off, yet these standard heads were stronger than the Manufacturers' heads oftener than the Manufacturers' heads were stronger than the U. S. standard heads. A still closer examination will disclose the fact that the range of difference of strength of heads was quite great. However, this difference of range of strength is shown more truly in the comparison which is to follow, of the percentages of strength compared to the strength of the shank of the bolt.

In case of the eccentric tests, when the head pulled off, the strength of the Manufacturers' head exceeded the strength of the U. S. standard head 31 times, while the strength of the U. S. standard head exceeded the strength of the Manufacturers' head only 11 times. The percent by which the Manufacturers' head was stronger than the U. S. standard head was uniformly greater than the same percent of higher strength of U. S. standard heads compared to Manufacturers' standard heads.

It will be seen that both in the tension and the eccentric tests the range of percent by which the strength of one standard exceeded the strength of the other is quite large, although it may be said again that this range of higher strength is shown in more correct proportion in the tables in which both tests are referred to a common quantity, the strength of the shank.

Probably for Table I the best comparison is that first outlined: the percent of bolts breaking in the body. On the whole, however, a comparison of the strength of the head when breaking is in favor of the Manufacturers' standard.

In Tables J and K is worked out a comparison of both standards as referred to a common quantity, i. e., the strength of the shank of the bolt. This strength of bolt is obtained directly in those cases when the bolt broke in the body; but when no bolts of a particular diameter broke in the body, its supposed strength was computed by interpolation from measured values of the strength of those bolts nearest in diameter. For this reason the strength of the shank given in the tables sometimes comes out greater than 100 per cent, in which case it would mean that the head pulled off at a higher load than the computed strength of the body of the bolt. It is somewhat of an absurdity, it is true, to include these values greater than 100 per cent in the table, but with this explanation they are allowed to remain. The deductions from this table are evident. In three makes of bolts out of four the Manufacturers' standard broke at a higher average percent of strength of shank of bolt than the U. S. standard. That is, a general average of 88.6 per cent for the Manufacturers' standard as against 87.8 for the U. S. standard. In one case the U. S. standard broke at 88.2 per cent as against 75.9 per cent for the Manufacturers' standard. Plate 3 gives a graphic comparison of these results.

Plates 4 and 5 show the percent of strength of the shank plotted against the diameter of the bolt for the four makes of bolts. It will seen that there is a general

tendency for an increased efficiency of bolt head as the diameter of the bolt gets larger; also, that the strengths of the two standards lie fairly close together. Indeed, comparing the averages of all four makes, there is no very decided indication that either one has the advantage.

ECCENTRIC TESTS.—The indications are, however, more definitely in favor of the Manufacturers' standard in case of the eccentric tests. Plate 3 shows the eccentric test to have the advantage, on the whole, in case of three makes out of four. From Plate 5, in which the percent of strength is plotted for the different diameters of bolts, it will be seen again that there is indication of increased efficiency of head as the diameter of bolt increases, and also that both in case of the individual makes of bolts and the average of these makes that the Manufacturers' standard has a higher percent of strength than the U. S. standard. This higher percent is, however, not a very large quantity.

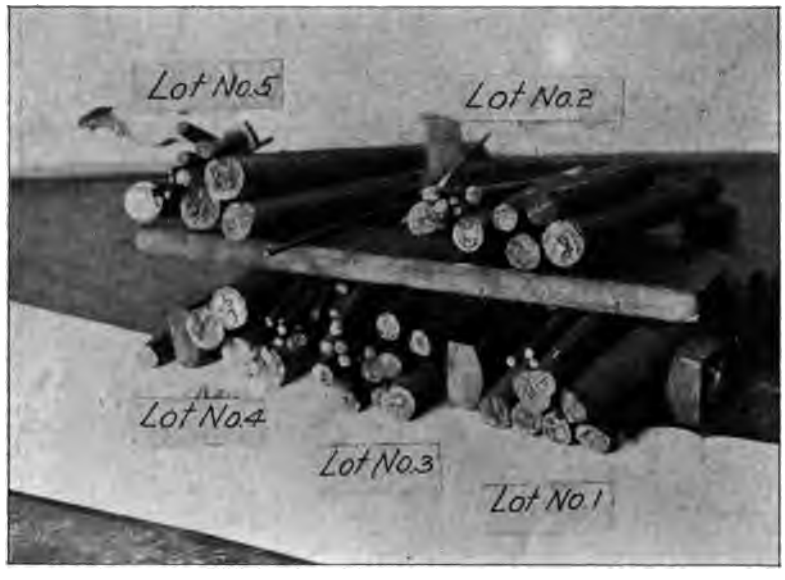
In Plate 6 is shown a diagram representing the tensile strength per square inch of the metal for the different diameters of bolts. This tensile strength runs more uniformly than might have been supposed.

FINAL SUMMARY OF TESTS.

The indication of the foregoing tables and diagrams is to the effect that the Manufacturers are correct in their statement that the Manufacturers' standard head is a better head than the larger U. S. standard head.

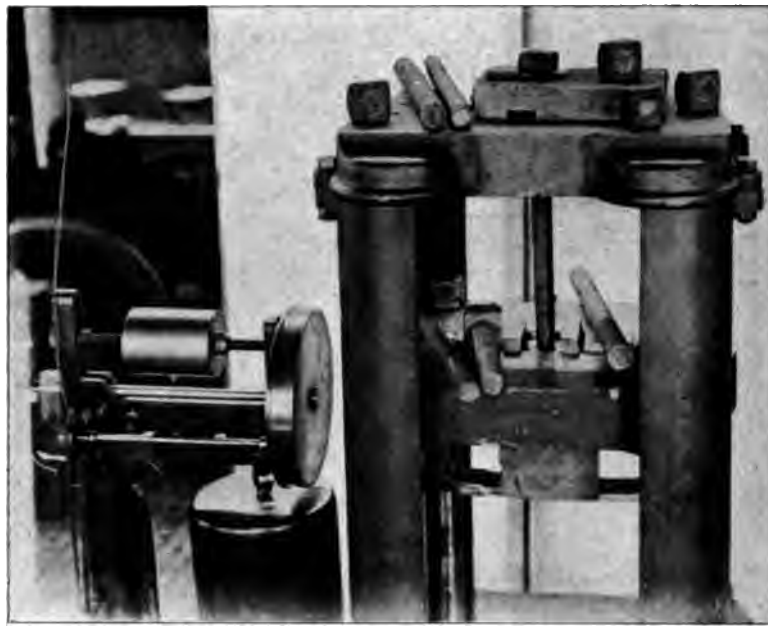
NOTE.—The writer desires to commend the intelligence and care shown by Messrs. Dufty and Wiselogel in carrying out these tests.

W. K. HATT.

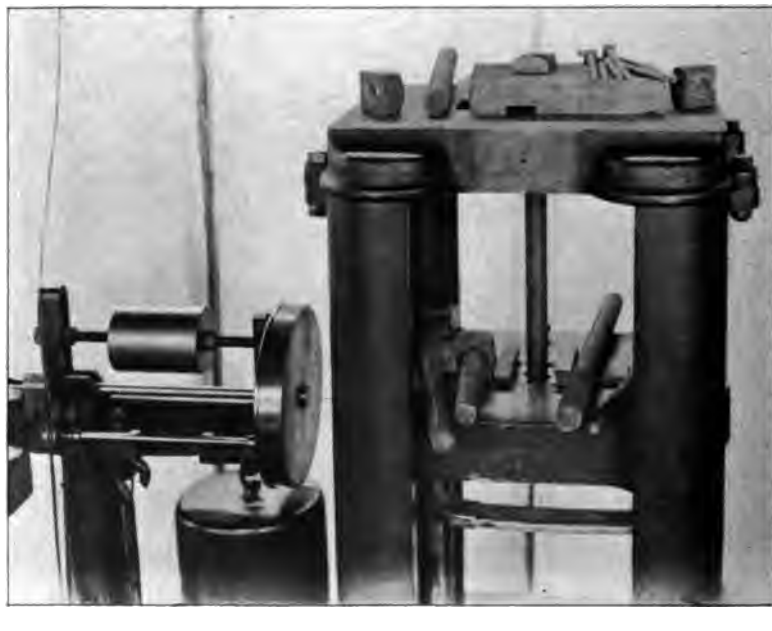


VIEW OF FRACTURED BOLTS.

VIEW OF HEADS.



Bolt Under Eccentric Test.



Bolt Under Tension Test.

LOT 5

TENSION TEST.

DUFTY & WISELOGEL — TABLE A — JUNE 7. '99.

No.	Diam	Size of Standard Head.	Load.	No.	Diam	Size of M'f'g's Head.	Load	Diff.
143 V	1/4	1/4 × 1/2 × 1/2	1240	153 +	1/4	3/16 × 3/8 × 3/8	3000	+
144 V			2270	154 +			2018	754
6 +	3/8	3/8 × 11/16 × 11/16	6495	162 +	3/8	5/16 × 5/8 × 5/8	6570	+
5 +			6545	161 +			6590	60
131 V	1/2	1/2 × 7/8 × 7/8	9935 -	4 V	1/2	7/16 × 13/16 × 13/16	11070	+
129 V			10940	1 +			11745 -	1220
113 V	5/8	5/8 × 1 1/16 × 1 1/16	17450	10 V	5/8	9/16 × 1 × 1	16420	+
115 V			13670	11 V			16340	1320
136 V	3/4	3/4 × 1 1/4 × 1 1/4	23720	174 +	3/4	5/8 × 1 3/16 × 1 3/16	26660	+
135 V			20420	176 +			26385	4952
123 +	7/8	7/8 × 1 7/16 × 1 7/16	37360	171 +	7/8	3/4 × 1 3/8 × 1 3/8	34215 -	-
124 V			33870	172 +			36070	472
22 +	1	1 × 1 5/8 × 1 5/8	47050	180 +	1	7/8 × 1 1/2 × 1 1/2	43792	+
23 +			44410	178 V			34000	6834
146 V	1 1/8	1 1/8 × 1 13/16 × 1 13/16	54490	151 +	1 1/8	1 × 1 5/8 × 1 5/8	46970	-
145 +			54850	150 +			54570	3900
126 V	1 1/4	1 1/4 × 2 × 2.	60370	181 +	1 1/4	1 1/8 × 1 15/16 × 1 15/16	52440	+
125 V			46500	182 +			61040	6610

STANDARD BOLT - - - - - BODY BROKE: 6. HEAD OFF: 12.

M'F'G'S BOLT - - - - " " 11 " " 7.

NO OF TIMES THE STD WERE STRONGER WHEN BODY BROKE 2

" " " " " " " HEAD PULLED OFF 3

" " " M'F'G'S " " " BODY BROKE 2

" " " " " " " HEAD PULLED OFF 2

TENSILE STRENGTH { 59600 / 57000 } ELAST. LIMIT: 37072, ELONGATION 2 1/4" in 8"

NOTE V = HEAD OFF: + = BODY BROKE. - = FAVOR OF STD + FAVOR OF M'F'G.

LOT 4

TENSION TEST

DUFTY & WISELOGEL — TABLE B. — JUNE 7. '99.

No.	DIAM.	SIZE OF STANDARD HEAD	LOAD	No	DIAM.	SIZE OF M'FG'S. HEAD.	LOAD.	DIFF.
185 V	1/4	1/4 x 1/2 x 1/2	2340	233 V	1/4	3/16 x 7/16 x 7/16	1230	−
188 V			2290	234 V			600	1900
191 V	3/8	3/8 x 11/16 x 11/16	5210	256 V	3/8	5/16 x 5/8 x 5/8	5220	−
189 +			6480	253 V			4970	750
214 V	1/2	1/2 x 7/8 x 7/8	10480	267 V	1/2	7/16 x 13/16 x 13/16	7625	+
216 V			10000	268 +			10260	1283
193 V	5/8	5/8 x 1 1/16 x 1 1/16	15140	248 V	5/8	1/2 x 1 x 1	12940	−
195 V			15680	247 V			11070	1340
243 V	3/4	3/4 x 1 1/4 x 1 1/4	20540	200 V	3/4	5/8 x 1 1/8 x 1 1/8	20850	+
250 V			15760	199 V			19400	2975
242 V	7/8	7/8 x 1 7/16 x 1 7/16	29400	204 +	7/8	11/16 x 1 3/8 x 1 3/8	31270	+
241 V			27470	202 V			30800	2600
245 +	1	1 x 1 5/8 x 1 5/8	39250	205 V	1	3/4 x 1 9/16 x 1 9/16	23190	−
247 +			39790	208 V			29585	13133
240 V	1 1/8	1 1/8 x 1 13/16 x 1 13/16	51625	217 V	1 1/8	1 x 1 11/16 x 1 11/16	49520	−
239 V			49705	220 V			33810	8995
251 V	1 1/4	1 1/4 x 2 x 2	54700	221 V	1 1/4	1 1/8 x 1 7/8 x 1 7/8	49480	−
254 +			59500	223 V			62120	1300

STANDARD BOLT − − − − − BODY'S BROKE, 4; HEAD'S OFF, 14.

M'FG'S " − − − − − " " 2 " " 16.

NO. OF TIMES THE STD WERE STRONGER WHEN BODY BROKE 0

" " " " " " " " " 8

" " " M'FG'S " " " BODY BROKE. 0

" " " " " " " HEAD PULLED OFF 4

TENS. STRENGTH. {52000 / 50000 ; ELAS. LIMIT. 37150 ; ELONGATION. 7" in 8".

NOTE:− V = HEAD OFF. + = BODY BROKE. − FAVOR OF STD. + FAVOR OF M'FG.

LOT 3

TENSION TEST.

DUFTY & WIGGLOGEL. TABLE C JUNE. 7. '99.

No.	DIAM.	SIZE OF STANDARD HEAD	LOAD.	No.	DIAM	SIZE OF M'F'G'S HEAD.	LOAD.	DIFF.
294	1/4	1/4 x 1/2 x 1/2	2015	330	1/4	3/16 x 3/8 x 3/8	1910	—
295			1870	332			1930	22
286	3/8	3/8 x 11/16 x 11/16	4580	347	3/8	5/16 x 9/16 x 9/16	5095	+
287			2304	348			5125	1668
281	1/2	1/2 x 7/8 x 7/8	8100	344	1/2	7/16 x 3/4 x 3/4	7980	—
283			8715	343			8240	297
298	5/8	5/8 x 1 1/16 x 1 1/16	13350	335	5/8	9/16 x 15/16 x 15/16	11510	+
300			13815	333			15870	108
280	3/4	3/4 x 1 1/4 x 1 1/4	16650	339	3/4	5/8 x 1 1/8 x 1 1/8	15820	+
270			17750	340			19920	670
290	7/8	7/8 x 1 7/16 x 1 7/16	26960	319	7/8	11/16 x 1 5/16 x 1 5/16	28570	+
289			21790	320			28365	4092
327	1	1 x 1 5/8 x 1 5/8	39680	328	1	3/4 x 1 1/2 x 1 1/2	38130	—
326			40600	325			39170	1490
356	1 1/8	1 1/8 x 1 13/16 x 1 13/16	53230	312	1 1/8	7/8 x 1 11/16 x 1 11/16	52520	+
353			46160	309			52100	2615
270	1 1/4	1 1/4 x 2 x 2	55670	314	1 1/4	1 x 1 7/8 x 1 7/8	57080	+
269			60310	312			61130	1115

STANDARD BOLT ----- BODY'S BROKE 1 ; HEAD'S OFF 17

M'F'G'S BOLT ----- " " 5 ; " " 13

NO OF TIMES THE STD WERE STRONGER WHEN BODY BROKE 1

" " " " " " " HEAD PULLED OFF 6

" " " M'F'G'S " " " BODY BROKE 0

" " " " " " " HEAD PULLED OFF 7

TENS. STRENGTH { 51260 / 52300 } ELAS. LIMIT. 33700 ELONGATION. .35" IN 8."

NOTE:— V = HEAD OFF + = BODY BROKE — FAVOR OF STD + FAVOR OF M'F'G.

LOT 1

TENSION TEST.

DUFTY & WISELOGEL — TABLE O — JUNE. 7. '99.

No.	DIAM.	SIZE OF STANDARD HEAD	LOAD.	No	DIAM.	SIZE OF M'F'G'S HEAD	LOAD.	DIFF.
78 V	1/4	1/4 x 1/2 x 1/2	2060	48 †	1/4	3/16 x 3/8 x 3/8	2965	+
77 V			2687	47 †			2710	459
111 V	3/8	3/8 x 11/16 x 11/16	4010	73 †	3/8	5/16 x 9/16 x 9/16	5600	+
112 V			4370	75 †			5670	1445
91 †	1/2	1/2 x 7/8 x 7/8	9150	59 †	1/2	3/8 x 3/4 x 3/4	8755	−
89 †			8940	58 †			8770	783
105 †	5/8	5/8 x 1 1/16 x 1/16	16690	44 †	5/8	1/2 x 1 x 1	16470	−
102 †			16360	41 V			15670	430
84 †	3/4	3/4 x 1 1/4 x 1 1/4	23240	49 †	3/4	9/16 x 1 1/8 x 1 1/8	22480	−
81 †			23020	52 †			22840	470
88 †	7/8	7/8 x 1 7/16 x 1 7/16	29910	35 †	7/8	5/8 x 1 3/8 x 1 3/8	30680	−
87 †			33320	33 †			30270	890
98 †	1	1 x 1 5/8 x 1 5/8	22070	40 †	1	3/4 x 1 1/2 x 1 1/2	27250	+
99 †			20450	39 †			26770	5750
95 †	1 1/8	1 1/8 x 1 13/16 x 1 13/16	49620	56 †	1 1/8	7/8 x 1 3/4 x 1 3/4	49725	+
93 †			46705	54 †			48950	1170
100 V	1 1/4	1 1/4 x 2 x 2	64050	66 †	1 1/4	1 x 1 7/8 x 1 7/8	62760	−
107 †			59780	67 †			63230	12577

STANDARD BOLT — — — — BODY'S BROKE 12; HEAD'S OFF 6

M'F'G'S BOLT — — — — " " 17; " " 1

NO OF TIMES THE STD WERE STRONGER WHEN BODY BROKE 6

" " " " " " " HEAD PULLED OFF 0

" " " M'F'G'S " " " BODY BROKE. 5

" " " " " " " HEAD PULLED OFF 0

TENS. STRENGTH. {44000 / 48000 ; ELAS. LIMIT 32850; ELONGATION. 4" in 8"

NOTE:- V = HEAD OFF; † = BODY BROKE; − FAVOR OF STD; + FAVOR OF M'F'G.

LOT 5

ECCENTRIC TEST

DUFTY & WISELOGEL TABLE E. JUNE 7. '99.

No	Diam.	Size of Standard Head	Load.	No	Diam.	Size of Mf'g's Head	Load	Diff.
140 +	1/4	1/4 x 1/2 x 1/2	2870	155 +	1/4	3/16 x 3/8 x 3/8	2960	+
141 V			200	142 V			2530	1620
119 V	3/8	3/8 x 11/16 x 11/16	2220	281 V	3/8	5/16 x 5/8 x 5/8	5465	+
118 V			3460	282 V			5250	1510
130 V	1/2	1/2 x 7/8 x 7/8	11750	157 +	1/2	7/16 x 13/16 x 13/16	11830	+
132 V			9210	158 V			10095	437
116 V	5/8	5/8 x 1 1/16 x 1 1/16	9230	12 V	5/8	9/16 x 1 x 1	10790	+
117 V			8405	9 V			12040	2598
133 V	3/4	3/4 x 1 1/4 x 1 1/4	17635	173 V	3/4	5/8 x 1 3/16 x 1 3/16	19300	+
134 V			17815	172 +			25640	4595
122 +	7/8	7/8 x 1 7/16 x 1 7/16	34260	170 +	7/8	3/4 x 1 3/8 x 1 3/8	35670	+
121 V			23870	169 +			35850	6695
21 +	1	1 x 1 5/8 x 1 5/8	44200	177 V	1	7/8 x 1 1/2 x 1 1/2	45150	−
24 +			47135	179 V			40810	2687
147 V	1 1/8	1 1/8 x 1 13/16 x 1 13/16	36520	152 V	1 1/8	1 x 1 5/8 x 1 5/8	30720	+
148 V			30550	149 V			44100	13875
128 +	1 1/4	1 1/4 x 2 x 2	54430	126 V	1 1/4	1 1/8 x 1 15/16 x 1 15/16	60370	+
127 +			52010	125 V			46500	430

STANDARD BOLT ------ BODY'S BROKE 4. HEAD'S OFF 14.

MF'G'S BOLT ------ " " 5. " " 13.

NO. OF TIMES THE STD WERE STRONGER WHEN BODY BROKE 0

" " " " " " " HEAD PULLED OFF 2

" " " MFG'S " " " BODY BROKE 2

" " " " " " " HEAD PULLED OFF 9

TENS STRENGTH {53600 / 54800; ELAST. LIMIT 37070; ELONGATION 2 1/4" in 8".

NOTE:- V = HEAD OFF; + = BODY BROKE; − FAVOR OF STD; + FAVOR OF MF'G.

LOT 4

ECCENTRIC TEST.

DUFTY & WISELOGEL. TABLE F. JUNE 7. '99.

No.	Diam.	Size of Standard Head.	Load.	No.	Diam.	Size of M'f'g's Head.	Load.	Diff.
235 V	1/4	1/4 x 1/2 x 1/2	770	186 V	1/4	3/16 x 7/16 x 7/16	2540	+
236 +			2290	187 +			1920	700
258 V	3/8	3/8 x 11/16 x 11/16	2990	192 V	3/8	5/16 x 5/8 x 5/8	4015	−
257 +			5220	190 +			3560	318
213 V	1/2	1/2 x 7/8 x 7/8	10530	214 +	1/2	7/16 x 13/16 x 13/16	10480	+
215 V			6940	216 V			10000	1505
245 V	5/8	5/8 x 1/16 x 1/16	7410	196 +	5/8	1/2 x 1 x 1	9520	+
246 +			9650	194 V			8775	617
247 +	3/4	3/4 x 1/4 x 1/4	16120	198 V	3/4	5/8 x 1 1/8 x 1/8	20250	+
249 V			11070	197 +			14650	3855
243 V	7/8	7/8 x 1 7/16 x 1 7/16	23235	203 +	7/8	11/16 x 1 3/8 x 1 3/8	25290	+
244 +			20125	201 V			26595	4262
246 +	1	1 x 1 5/8 x 1 5/8	38900	206 V	1	3/4 x 1 9/16 x 1 9/16	36770	−
248 +			37440	207 +			12860	3355
219 V	1 1/8	1 1/8 x 1 13/16 x 1 13/16	50695	237 +	1 1/8	1 x 1 11/16 x 1 11/16	44170	+
218 V			50850	238 +			58160	393
253 V	1 1/4	1 1/4 x 2 x 2	50200	222 V	1 1/4	1 1/8 x 1 7/8 x 1 3/8	52590	+
254 +			36320	224 V			50930	8455

STANDARD BOLT – – – – – BODY'S BROKE 4. HEAD'S OFF. 14.

M'F'G'S BOLT – – – – – BODY'S " 2. " " 16

NO. OF TIMES THE STD WERE STRONGER WHEN BODY BROKE. 0

" " " " " " " HEAD PULLED OFF. 2

" " " M'F'G'S " " " BODY BROKE. 0

" " " " " " " HEAD PULLED OFF. 10

TENS. STRENGTH { 52000 / 50000 ; ELAS. LIMIT 37150 ; ELONGATION. MIN 8"

NOTE:– V = HEAD OFF; + = BODY BROKE; – FAVOR OF STD; + FAVOR OF M'F'G.

LOT 3

ECCENTRIC TEST.

DUFTY & WISELOGEL. TABLE G. JUNE. 7. '99.

No.	Diam.	Size of Standard Head.	Load.	No.	Diam.	Size of Mf'g's Head.	Load.	Diff.
296	1/4	1/4 x 1/2 x 1/2	1490	328	1/4	3/16 x 3/8 x 3/8	1450	–
293			1900	331			1770	85
285	3/8	3/8 x 11/16 x 11/16	2000	345	3/8	5/16 x 9/16 x 9/16	3040	+
288			2000	346			3380	1210
282	1/2	1/2 x 7/8 x 7/8	6190	341	1/2	7/16 x 3/4 x 3/4	6920	+
284			6560	342			7230	700
299	5/8	5/8 x 1/16 x 1/16	10230	298	5/8	9/16 x 15/16 x 15/16	11390	+
297			8180	296			7330	150
278	3/4	3/4 x 1/4 x 1/4	17970	337	3/4	5/8 x 1 1/8 x 1 1/8	10150	–
277			14480	338			16420	3040
291	7/8	7/8 x 1 7/16 x 1 7/16	11030	318	7/8	11/16 x 1 5/16 x 1 5/16	19480	+
292			15680	317			16150	4460
279	1	1 x 1 5/8 x 1 5/8	29950	278	1	3/4 x 1 1/2 x 1 1/2	29950	+
276			24215	275			30090	2912
311	1 1/8	1 1/8 x 1 13/16 x 1 13/16	45750	355	1 1/8	7/8 x 1 11/16 x 1 11/16	41080	+
310			42890	354			45680	1880
315	1 1/4	1 1/4 x 2 x 2.	34070	271	1 1/4	1 x 1 7/8 x 1 7/8	45200	+
316			57910	272			57770	5495

STANDARD BOLT – – – – BODY'S BROKE; 0: HEAD'S OFF; 18.

M'F'G'S " – – – – – – " " 0 " " 18

NO. OF TIMES THE STD WERE STRONGER WHEN BODY BROKE, 0.

" " " " " " " HEAD PULLED OFF, 6.

" " " M'F'G'S " " BODY BROKE, 0.

" " " " " " HEAD PULLED OFF, 11.

TENS. STRENGTH {51260 / 52300}; ELAS LIMIT. 33700. ELONGATION. 35" in 8"

NOTE:- V = HEAD OFF; + = BODY BROKE; – FAVOR OF STD; + FAVOR OF M'F'G.

LOT 1

Eccentric Test.

Dufty & Wiselobel. TABLE H June, 7. '99.

No	Diam.	Size of Standard Head.	Load.	No.	Diam	Size of M'f'gs Head.	Load.	Diff.
79 +	1/4	1/4 x 1/2 x 1/2	2410	46 v	1/4	3/16 x 3/8 x 3/8	2420	—
80 +			2750	45 v			2480	130
110 v	3/8	3/8 x 11/16 x 11/16	4225	76 +	3/8	5/16 x 9/16 x 9/16	5750	+
109 v			4470	74 +			5700	1328
90 +	1/2	1/2 x 7/8 x 7/8	7270	60 +	1/2	3/8 x 3/4 x 3/4	9530	+
92 +			6480	57 v			6900	1340
101 +	5/8	5/8 x 1 1/16 x 1/16	16750	42 +	5/8	1/2 x 1 x 1	16500	+
104 v			15080	43 +			16710	840
82 +	3/4	3/4 x 1 1/4 x 1/4	22910	51 +	3/4	9/16 x 1 1/8 x 1 1/8	22610	-
83 +			23490	50 +			22880	430
85 +	7/8	7/8 x 1 7/16 x 1 7/16	31700	34 v	7/8	5/8 x 1 3/8 x 1 3/8	30500	+
86 +			27780	36 +			30860	940
100 v	1	1 x 1 5/8 x 1 5/8	37180	37 v	1	3/4 x 1 1/2 x 1 1/2	37930	+
97 +			39695	38 +			39250	178
94 +	1 1/8	1 1/8 x 1 13/16 x 1 13/16	47885	55 +	1 1/8	7/8 x 1 3/4 x 1 3/4	49380	+
96 v			45000	53 +			49690	3093
105 +	1 1/4	1 1/4 x 2 x 2	59130	65 +	1 1/4	1 x 1 7/8 x 1 7/8	62080	—
106 v			64000	68 +			62850	900

Standard Bolt ---- Body's Broke 6; Head's off 12.

M'f'g's " ------ " " 13; " " 5

No of times the St'd were Stronger when Body Broke 3

" " " " " " " Head Pulled off 0

" " " M'f'gs " " " Body Broke 0

" " " " " " " Head Pulled off 2

Tens. Strength {47000 / 48000}; Elas. Limit 32850; Elongation .4" in 8"

Note - v = Head off; + = Body Broke; - Favor of St'd; + Favor of M'f'g.

— SUMMARY SHEET. —

DUFTY & WISELOGEL. TENSION TABLE I. JUNE. 7. '99.

LOT	STANDARD BOLTS.							MANUFACTURERS BOLTS.							TENSILE STRENGTH	ELASTIC LIMIT	% OF ELON.
	No of Bodys. Broke.	Percent of U.S.St. Bolts Br. in Body	No. of Heads Off.	No. of times stronger when: Body Broke	No. of times stronger when: Head off.	Ave% Inc. Strn over Manuft.	Preceeding % of	No. of Body's Broke	Percent of Mfrs Br. in Body	No. of Heads Pulled off.	No. of times stronger when: Body Broke	No. of times stronger when: Head off	Ave% Inc. Strength over Manuft. Standard	Preceeding % of			
5	6	33	12	2	3	10.9	13.8-6	11	61	7	2	2	15.4	16-15	57240	37872	28.1
4	4	22	14	0	8	30	7.3-0	2	11	16	0	4	11.0	19-0	55068	37150	8.7
3	1	5.5	17	1	6	5.3	55-1	5	28	13	0	7	16.7	17-1	51780	33700	4.4
1	12	66	6	6	0	0	0	17	94	1	5	0	0	0	46538	32850	5.0
TOTAL	23	AVE. 31.9	49	9	17			35	AVE. 48.7	37	7	13	AVE.				
ECCENTRIC.																	
5	4	22	14	0	2	16		5	28	13	2	9	31	92-8	57240	37872	28.1
4	4	22	14	0	3	17	9-3	2	11	16	0	9	26.4	70-4	55068	37150	8.7
3	0	0	18	0	6	12.6	43-0	0	100	18	0	11	17.3	38-3	51780	33700	4.4
1	6	33	12	3	0	0		13	72	5	0	2			46538	32850	5.0
TOTAL	14	AVE. 19.4	58	3	11			20	27.7	52	2	31					

LOT 2

Tension and Eccentric Test.

BUTTY & WIEGLOOLL — JUNE. 7. 99.

No.	Diam.	Size of Head	Load in Tension	No	Diam.	Load in Eccentric	Tested Strength in % of Computed Strength. Computed Strength.	Percent Tension	Percent Ecc.
373+	1/4	3/16 x 3/8 x 3/8	2185	371+	1/4	3050	2808	75	101
374+			1900	372+		3190		68	101
364+	3/8	5/16 x 5/8 x 5/8	5840	366+	3/8	5830	5870	100	100
363+			6000	365+		5810		100	99
359+	1/2	7/16 x 3/4 x 3/4	10480	360+	1/2	10575-	10593	100	100
362+			10380	361+		10740		98	100
370+	5/8	1/2 x 1 x 1	13815	367+	5/8	17000	16268	85	100
369+			17120	368+		17140		100	100
377+	3/4	9/16 x 1 1/8 x 1/8	20465	376+	3/4	20630	20536	99	100
378+			20600	375+		20450		100	99
356+	7/8	11/16 x 1 3/8 x 1 3/8	30580	355+	7/8	30340	30405-	100	100
357+			26765	353+		30470		88	100
383+	1	13/16 x 1 1/2 x 1 1/2	40210	357+	1	39650	39908	100	99
384+			39925	360+		39850		100	100
381+	1 1/8	15/16 x 1 3/4 x 1 3/4	48070	379+	1 1/8	47670	47448	100	100
382+			46453	380+		47600		98	100
393+	1 1/4	1 1/16 x 2 x 2	65740	391+	1 1/4	67230	66638	98	100
394+			66295	392+		67290		99	100

	Tens.	Ecc.
No. of Times the Body Broke.	15	18
" " " " Heads Pulled off.	3	0

Average Percent in Tension. 94.8

" " " Eccentric. 99.9

Ten. Strength. 47448 Elas. Limit. 42000 Elong. $1\frac{3}{4}$" in 8"

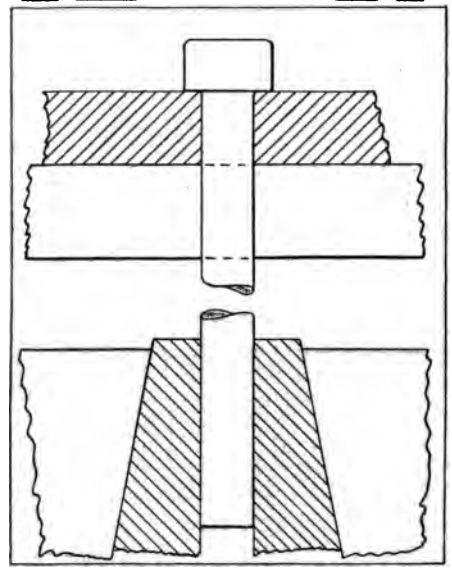
Note √ = Head off ' + = Body Broke.

All Upson Bolts Received were M'f'g's Standard.

TENSION TEST.

— PLATE No. 1. —

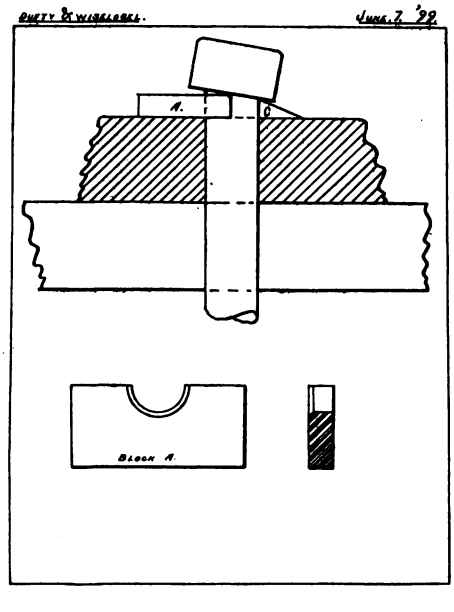
DUFFY & WIGGLESBEE. JUNE 7. '99.



ECCENTRIC TEST.

— PLATE No. 2. —

DUFFY & WIGGLESBEE. JUNE 7 '99.



DUFFY & WISELOGEL. TABLE J. JUNE. 7 '99.

SUMMARY — SHEET. — TENSION.

— TESTED STRENGTH IN PERCENT OF COMPUTED STRENGTH OF SHANK. —

DIAM. OF BOLT.	TESTED STRENGTH.				Lot No.5			Lot No.4			Lot No.3			Lot No.1			AVERAGES	
	BUFF.	MICH.	PENN.	L.ERIE	COMP. STRENGTH	STD.	M'F'G.	COMP. STRENGTH	STD.	M'F'G.	COMP. STRENGTH	STD.	M'F'G.	COMP. STRENGTH	STD.	M'F'G.	ST'D	M'F'G.
1/4	3000	?	?	2480	3000	40 / 75	100 / 67	4590	51 / 50	27 / 13	2700	74 / 69	70 / 71	2480	83 / 101	102 / 101	67.9	68.3
3/8	6580	6480	?	5630	6580	98 / 99	99 / 101	6480	81 / 100	81 / 77	6340	72 / 37	80 / 81	5630	71 / 77	100 / 100	79.4	89.8
1/2	11745	10260	?	8900	11745	85 / 93	99 / 100	10260	100 / 100	76 / 100	11100	73 / 79	72 / 75	8900	100 / 100	98 / 98	91.3	89.8
5/8	?	?	15870	16500	19065	92 / 72	85 / 85	17260	89 / 92	75 / 65	15870	84 / 87	73 / 100	16500	100 / 100	100 / 95	89.5	84.8
3/4	26380	?	?	22800	26385	91 / 78	100 / 100	24200	85 / 65	86 / 82	23800	70 / 74	66 / 83	22800	100 / 100	99 / 98	82.3	89.3
7/8	35880	31270	?	30900	35880	101 / 94	96 / 100	31270	94 / 88	100 / 99	31700	85 / 68	90 / 89	30900	96 / 101	100 / 99	91.0	96.6
1	45080	39520	38130	25000	45080	101 / 98	97 / 75	39520	100 / 100	59 / 75	38130	101 / 101	100 / 101	25000	88 / 82	101 / 101	96.3	88.6
1 1/8	54850	?	52600	48700	54850	100 / 100	86 / 100	49500	101 / 100	100 / 68	52600	100 / 88	100 / 100	48700	100 / 96	100 / 100	98.1	94.3
1 1/4	61040	59300	61130	61900	61040	99 / 76	86 / 100	59500	92 / 100	83 / 101	61130	92 / 99	93 / 100	61900	100 / 97	100 / 100	94.4	95.4
AVERAGES.						88.3	93.1		88.2	75.9		80.7	85.8		94	99.5	87.8	88.6

NOTE:- HEADS OFF OF ALL THOSE MARKED

TOTAL. STD 87.8 %
M'F'G 88.6 %

DUFFY & WISELOGEL. TABLE K. JUNE. 7. '99.

SUMMARY — SHEET. — ECCENTRIC.

— TESTED STRENGTH IN PERCENT OF COMPUTED STRENGTH OF SHANK. —

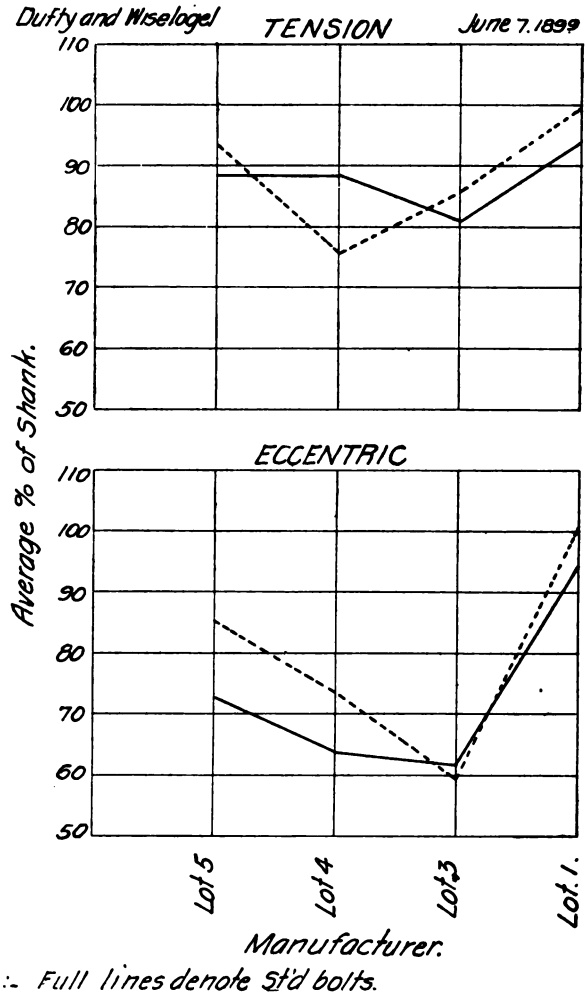
DIAM OF BOLT	TESTED STRENGTH.				Lot No.5			Lot No.4			Lot No.3			Lot No.1			AVERAGES	
	BUFF.	MICH.	PENN.	L.ERIE.	COMP. STR'G'H	STD	MFG	COMP. STRENGTH	STD	MFG	COMP. STR'G'H	STD	MFG	COMP. STR'G'H	STD	MFG	STD	MFG
1/4	3000	?	?	2080	3000	96 V 67	99 V 85	4590	17 V 50	55 V 42	2700	58 V 70 V	54 V 66	2480	99 100 V	99 V 100 V	69.2	74.1
3/8	6580	6480	?	5630	6580	34 V 53	83 V 80 V	6480	46 V 81 V	62 V 55	6340	32 V 32 V	48 V 53	5630	75 V 79 V	100 100	54.0	72.6
1/2	11745	10260	?	8900	11745	100 V 79 V	100 96 V	10260	100 V 67 V	100 98 V	11100	56 V 65 V	62 V 65 V	8900	82 V 73 V	101 77 V	77.7	87.4
5/8	?	?	15810	16500	19065	49 V 44 V	57 V 63 V	17260	93 V 56 V	55 V 51 V	15870	64 V 51 V	71 V 46 V	16500	100 92 V	100 100	62.3	67.9
3/4	26380	?	?	22810	26385	67 V 68 V	74 V 98	24200	66 46 V	84 V 61 V	23800	71 V 61 V	43 V 69 V	22800	100 100	99 100	72.4	78.5
7/8	35880	31270	?	30900	35880	96 66 V	99 100	31270	74 V 64 V	86 V 86 V	31700	35 V 49 V	61 V 51 V	30900	100 90 V	99 V 99	71.8	85.0
1	45080	39520	38130	25000	45080	99 100	100 V 91 V	39520	98 95	93 V 33 V	38130	78 V 64 V	78 V 77 V	25000	115 V 116 V	115 V 116	95.6	87.9
1 1/8	54850	?	52600	48700	54850	67 V 56 V	56 V 81 V	49500	100 100	89 V 102	52600	87 V 81 V	79 V 87 V	48700	98 V 92 V	100 100	85.1	86.7
1 1/4	61090	59500	61130	61900	61040	89 V 85 V	98 V 76 V	59500	84 V 61 V	88 V 85 V	61130	56 V 94 V	74 V 94 V	61900	96 V 100 V	100 100	83.1	89.3
AVERAGES.						73.1	85.3		63.8	73.6		61.6	53.9		94.8	100.2	74.5	81.1

NOTE:- HEADS PULLED OFF OF ALL THOSE MARKED V.

TOTAL:- STD 74.5 %
MFG 81.1 %

Plate 3

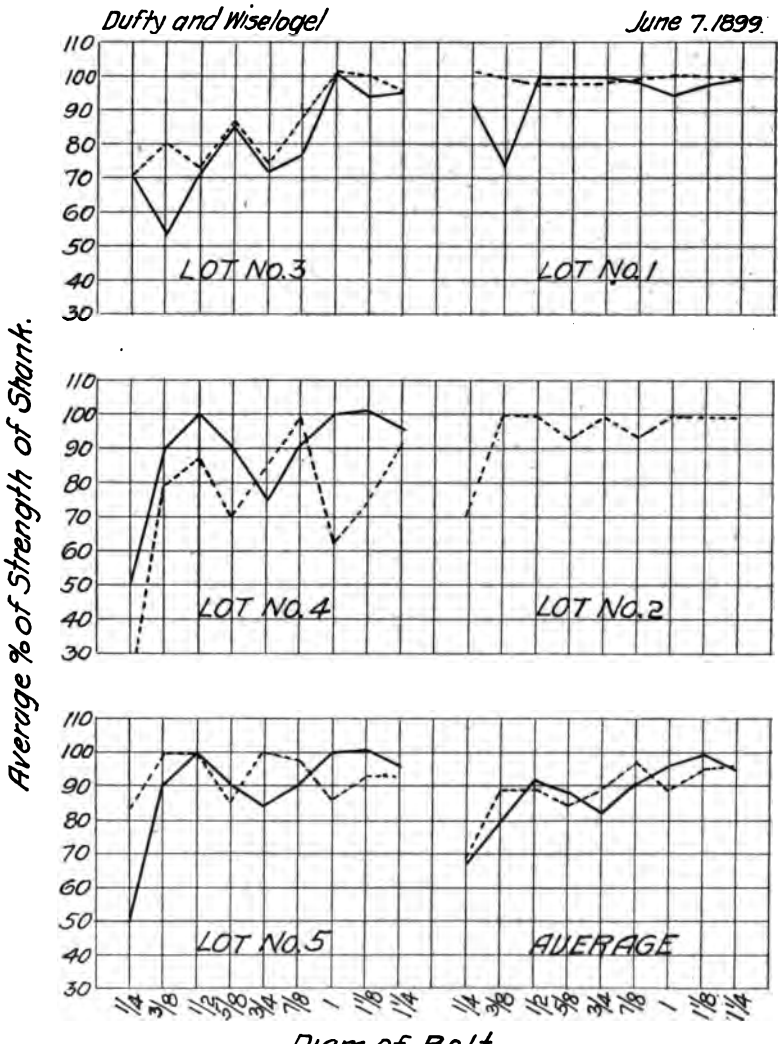
PLOTTED DIAG. BETWEEN MAKE AND AVE % STRNGH OF SHANK.



Note:- Full lines denote Std bolts.
Dotted " " Mfys "

TENSION TEST Plate 4.

PLOTTED DIAG. BETWEEN DIAM. AND AVE. ST. OF SHANK.

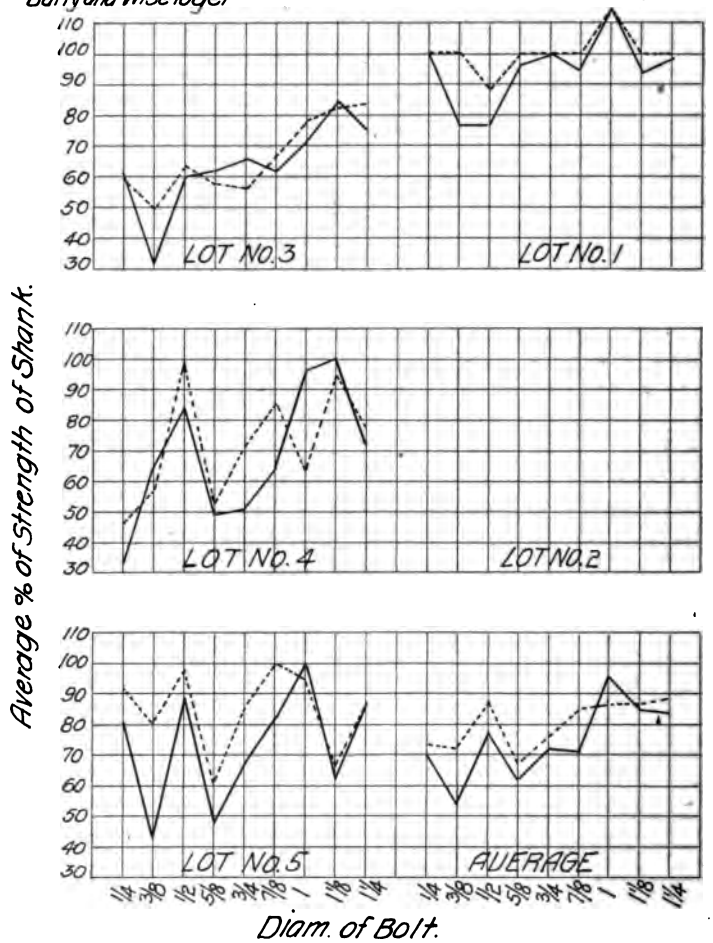


Note:- Full lines denote Std bolts
Dotted " " Mfgr's. "

ECCENTRIC TEST. Plate 5.

PLOTTED DIAG. BETWEEN DIAM. AND AVE % STR'NG. OF SHANK.

Duffy and Wiselogel June 7. 1899.

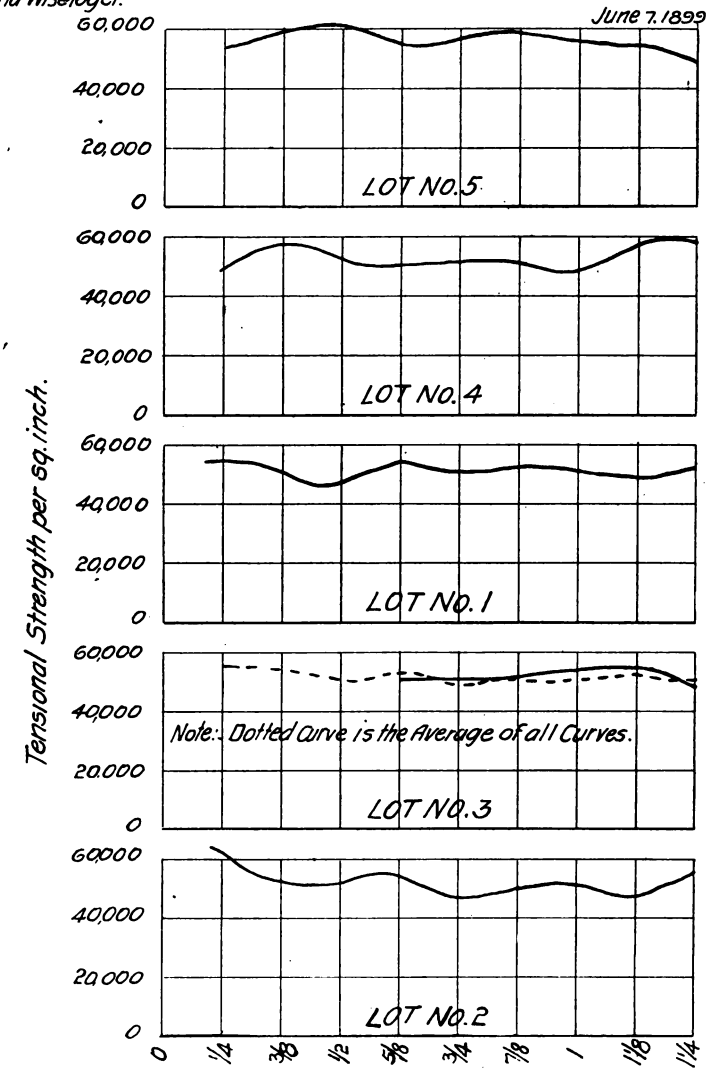


Note:- Full lines denote Std. bolts.
Dotted " " Mfg's. "

Plate 6

PLOTTED DIAG. BETWEEN TENS. ST. PER SQ. IN. AN DIAMETERS.

Duffy and Wiselogel.



It will be seen from Professor Hatt's report that there is evidently ample strength in the smaller heads, and that as far as the question of strength is concerned, there is no reason why a smaller head than the M. C. B. or M. M. standard cannot be used, and we recommend the following standard for square bolt heads:

The short diameter of head shall be one and one-half times the diameter of the bolt, and the thickness of head shall be one-half the short diameter of the head.

Figure No. 1 shows the relative size of the M. C. B. standard and our proposed standard.

As regards square nuts, we recommend that no change in present standard be made, as it is believed that there is no demand for it, and the replies from the different roads show that there is no difficulty in getting them of M. C. B. standard.

While it is true that there may be some disadvantages in having bolt heads and nuts of different size on account of difficulty in using wrenches, it is believed that wrenches can easily be made in "S" form, fitted at one end for the nut and at the opposite end for the bolt head. It is also believed that it is not safe to make the short diameter of the nuts any less, as this would result in greater liability of the nut splitting.

In support of our recommendations, we submit the following:

First. The statements of Professor Hatt that the test shows that the Manufacturers are correct in their statement that the Manufacturers' standard head is a better head than the larger U. S. standard head, and of the lots tested, lot No. 1 shows the best results and conforms very closely to our recommended standard. The results of the test show that this recommended standard is amply strong, and that therefore the extra amount of metal in the M. C. B. standard is uncalled for and that the extra amount of labor and loss of time necessary to make the M. C. B. standard is uncalled for.

Second. The evident fact that it is impossible to maintain the present M. C. B. standard, due to extra cost of bolts, and inability at times to obtain them.

Third. The evident fact that the results of tests made and information contained in this report will make it more difficult to maintain present M. C. B. standard, as car builders and bolt manufacturers will be in a position to claim and prove that the M. C. B. standard is uncalled for as far as strength is concerned, and to substantiate their claims in regard to increased cost of M. C. B. standard.

In connection with this matter it was thought best to recommend the adoption of a standard bolt head and nut gauge. A sample gauge, now in use by one railroad, is herewith submitted and will be shown by the secretary.

This was found to be a very handy tool and it is one that can be easily made. The steps on the side show the short diameter and the figures on the center show the thickness of the head.

B. HASKELL,
W. H. LEWIS,
THOS. FILDES,
Committee.

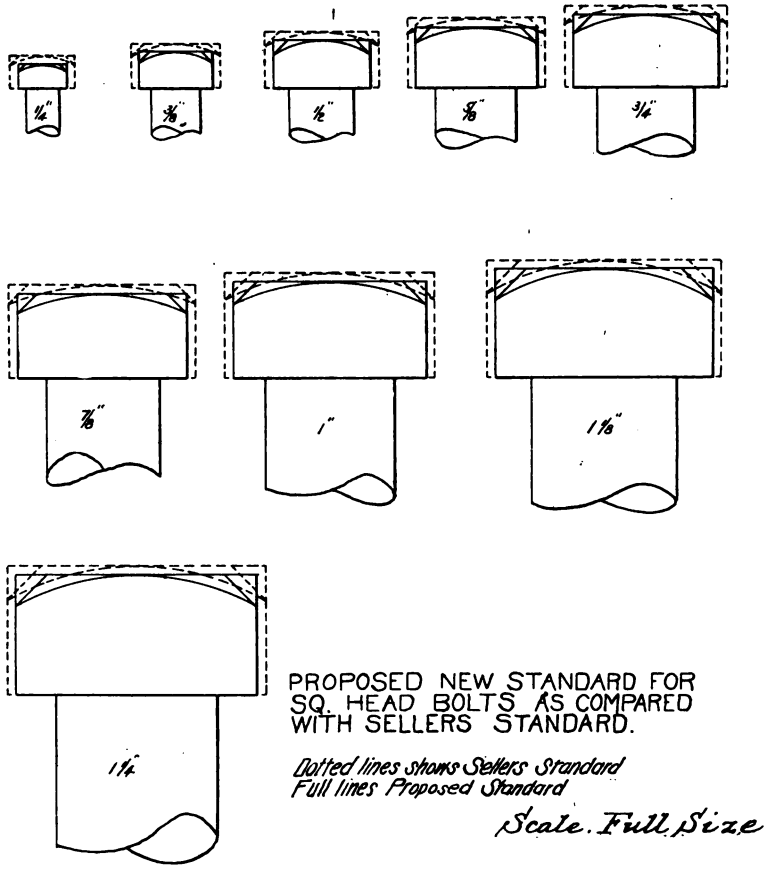

1/4"
3/8"
1/2"
5/8"
3/4"
7/8"
1"
1 1/8"
1 1/4"
PROPOSED NEW STANDARD FOR SQ. HEAD BOLTS AS COMPARED WITH SELLERS STANDARD.
Dotted lines shows Sellers Standard
Full lines Proposed Standard
Scale. Full Size

FIG. 1.

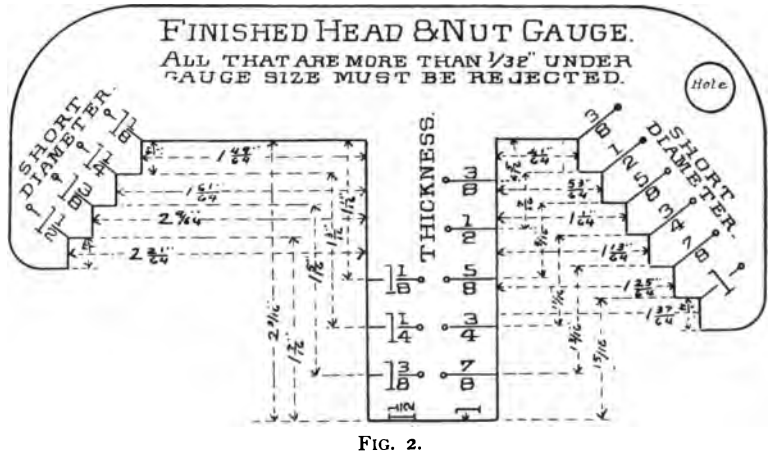

FINISHED HEAD & NUT GAUGE.
ALL THAT ARE MORE THAN 1/32" UNDER GAUGE SIZE MUST BE REJECTED.
Hole
SHORT DIAMETER
THICKNESS.
SHORT DIAMETER.

FIG. 2.

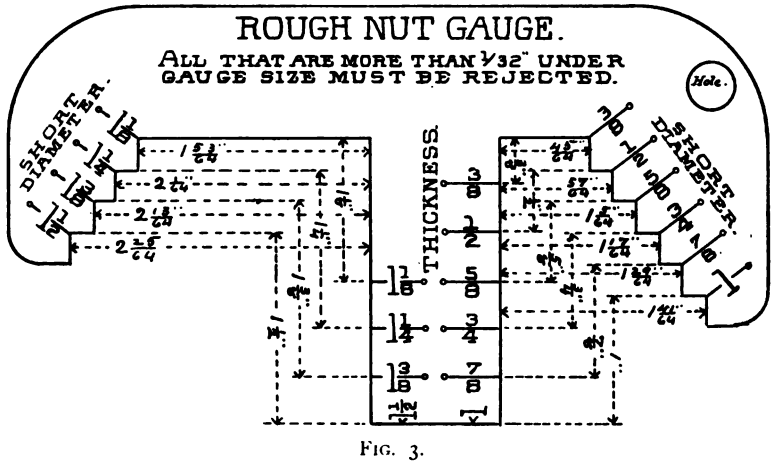

ROUGH NUT GAUGE.
ALL THAT ARE MORE THAN 1/32" UNDER GAUGE SIZE MUST BE REJECTED.
Hole.
SHORT DIAMETER.
THICKNESS.
SHORT DIAMETER.

FIG. 3.

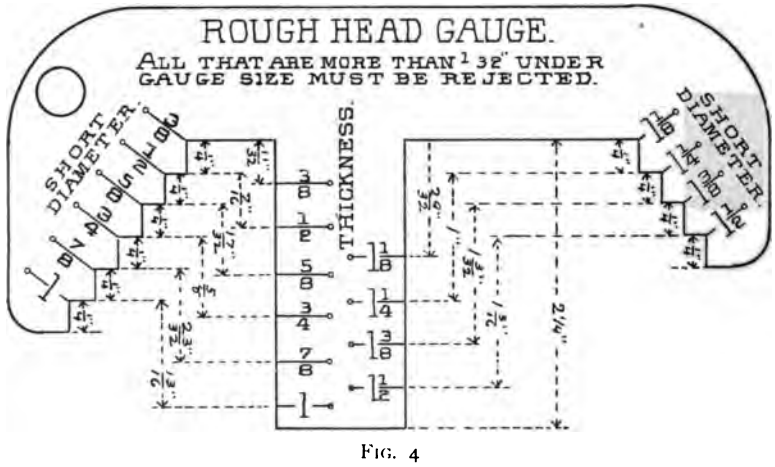

ROUGH HEAD GAUGE.
ALL THAT ARE MORE THAN 1/32" UNDER GAUGE SIZE MUST BE REJECTED.
SHORT DIAMETER.
THICKNESS.
SHORT DIAMETER.

FIG. 4

MR. QUEREAU: In connection with this, I would like to say that through a misunderstanding — how it occurred, or where, makes no difference — this report is not exactly in the shape in which it should be. You will note that the heading is "Square Head Bolts and Nuts: Standards for Pipe Fittings." A similar committee was appointed by the Master Car Builders' Association. Those two committees have been working in conjunction with a committee appointed by the American Society of Mechanical Engineers, and in order to expedite the work and not confuse it, the Master Car Builders' committee did nothing except to work on the matter of square head bolts and nuts. The Master Mechanics' committee worked simply on the standard thread for wrought iron pipes. This report should have had, at the bottom, the signature of the Master Car Builders' committee on the same subject, which would have put it in the shape intended by the Associations. The chairman of the Master Car Builders' committee, after reading this report, agreed to sign it for his committee. Now I would like to suggest that in accepting this report, or whatever disposition may be made of it, this Association should also take into consideration the report of the Master Car Builders' committee on the subject of square head bolts and nuts. The Master Car Builders' Association accepted the report, and by a motion are to send out a letter ballot deciding whether they shall adopt, or not, as standard, the recommendations made by the committee on square head bolts and nuts.

THE PRESIDENT: You have heard the report, gentlemen. What is your pleasure?

MR. WEST: I move that it be received and opened for discussion.

The motion was carried.

THE PRESIDENT: The paper is before you. Do not forget the recommendations made by the chairman.

MR. LEWIS: Mr. Quereau has explained the situation so far as the joint action of the committees is concerned, and I, as a member of the committee of the Master Car Builders' Association, was requested by the chairman to concur in the recommendations made by that portion of the committee that considered the question of pipe fittings, and I therefore do that, Mr. President, formally.

THE PRESIDENT: Is there a second to that?

MR. BROWN: I second the motion.

THE PRESIDENT: In order to carry out the recommendation of Mr. Quereau, the chairman of this committee, and in order that we may be able to confirm the action of the Master Car Builders, he has moved — will you repeat that, Mr. Lewis?

MR. LEWIS: In behalf of the chairman, I concur with him in indorsing the report made by this committee on pipe fittings.

THE PRESIDENT: Mr. Lewis, you understand, gentlemen, was a member of the committee that made that report to the Master Car Builders, and if we act on it and concur in his recommendation, it will be a part of our minutes. You have heard the motion. All those who concur in it say "aye"; contrary minded, "no." (Carried.)

THE PRESIDENT: Mr. Quereau, you had better come here and straighten this out.

MR. QUEREAU: There is one thing that I would like to state — and I request that the Secretary do not take down the names of the firms to which I refer as not living up to the action which I indorse. [The remarks of Mr. Quereau which immediately followed were not taken down.] So far as I am personally concerned, nothing would please me better than to have the exact facts in the case go into the minutes of this convention, if such is the feeling of the Association. I believe it would do as much as any one thing to straighten this matter out. It is a matter of opinion, or prejudice, if you please, rather than principle, which makes a bad job of what might otherwise be a very efficient standard. Personally, I should like to see it go into the minutes. But in deference to what I deemed was the opinion of this Association, I made the remarks I did about leaving it out. I should be glad personally to see it go into the proceedings.

THE PRESIDENT: Then, if there is no objection, they will be included.

MR. QUEREAU: The suggestion I make is this — personally I think it is a wise thing to include these names. If the convention thinks otherwise, it is for them to say.

THE PRESIDENT: What is your pleasure? Shall we include the names given?

MR. WEST: I move that the names be included.

The motion was carried.

MR. WEST: I move that his entire remarks, the Westinghouse matter ——

MR. QUEREAU: One moment. There will be no objections there. The Westinghouse people will not stand in our way a moment. I will send the exact facts to the Secretary.

MR. BARR: Mr. Chairman, I would like to ask the committee whether, in their investigations, they came across any other cases of non-adherence to the Briggs standard?

MR. QUEREAU: Answering Mr. Barr, I would say that we did. The names I can not now remember, but I can furnish them, and in my opinion, from the investigation made at that time, there will be little resistance on the part of any other firms than those which I mentioned.

MR. BARR: Now, to put the matter in a nice light, I would move that this committee be requested to furnish the names of the manufacturers of pipe fittings and pipe who do adhere and who do not adhere to the Briggs standard. (Seconded.)

THE PRESIDENT: Gentlemen, you have heard the motion, which has been regularly made and seconded, that the chairman of the committee furnish the names of the manufacturers who do adhere to the standard and those who do not adhere to the standard, and that they be placed on our record.

MR. BARR: A special mention of these parties might just as well be omitted then?

MR. QUEREAU: Yes.

MR. BARR: Instead, apparently, of the Association making them a target.

THE PRESIDENT: That is understood.

MR. QUEREAU: May I make a suggestion — Mr. Barr may possibly concur in it — that the committee furnish the names of manufacturers of pipe who adhere to the standard of pipe threads.

MR. BARR: And who do not?

MR. QUEREAU: I say leave that out.

MR. BARR: No.

THE PRESIDENT: All in favor of the motion say "aye"; contrary minded, "no."

The motion was carried.

MR. CLOUD: There was a committee on square head bolts and nuts in the Master Car Builders' Association. This same thing occurred in the Master Car Builders' convention. The Secretary had no advice that those two committees divided this matter up and that the committee of the Master Car Builders took the first end of it and the committee of the Master Mechanics' Association the second end of it. I think, therefore, it may be your wish to have the report of the committee which was presented to the Master Car Builders' Association on square head bolts and nuts incorporated in the proceedings of this Association as a part of this committee's report, because, as I understand Mr. Quereau, the committees did really act as a joint committee and both committees concurred in both reports. In that case the whole substance of both reports ought to go into both proceedings. Is it your desire to have the report of the committee of the Master Car Builders' Association on square head bolts and nuts included in the proceedings? If any of you have not seen those reports I have a few left here and you may have copies, though I presume most of you got copies in the Master Car Builders' Convention.

MR. MCCONNELL: I move that the Master Car Builders' report in this connection be attached to the report of Mr. Quereau and incorporated in the proceedings of the convention.

THE PRESIDENT? You have heard the motion, gentlemen, that the Master Car Builders' report on this same subject be attached to our report and incorporated in the minutes.

The motion was carried.

THE PRESIDENT: That disposes of that.

MR. QUEREAU: Has the Association adopted the recommendation of the committee in this report or not? If they have adopted it, there is something I want to propose.

THE PRESIDENT: Your motion did not include the acceptance of the report, did it, Mr. McConnell?

MR. MCCONNELL: No, sir; that was made by Mr. West.

THE PRESIDENT: Gentlemen, a motion for the adoption of the report is in order.

MR. MCCONNELL: I move that this convention adopt the report of this committee.

THE PRESIDENT: All in favor of that motion say "aye"; contrary, "no."

The motion was carried.

MR. QUEREAU: Do I understand that that carries the adoption of the recommendation of the committee?

MR. MCCONNELL: That was my motion.

MR. QUEREAU: If that is true, there are a few remarks I would like to make to clinch the nail. In order to make the recommendation of the adoption of this standard effective, it is necessary in some way to interest the chiefs of motive power and the purchasing agents of different railways in the specifications. In this connection I would like to say that I am assured the Westinghouse Air Brake Company will put nothing in the way of the successful adoption of the Briggs standard, as determined by Pratt & Whitney gauges. In order to clinch the nail, as I expressed it a moment ago, I would offer this motion:

"Moved, That the Secretary, on behalf of the Association, send to the heads of motive power departments a circular letter containing a summary of this report, requesting them to use their best efforts to have a specification for wrought-iron pipes, including the table of dimensions," (which gives the standard threads) "and in line with the action of this Association, adopted as standard"— which ought to have been a standard thirteen years ago. (Seconded.)

THE PRESIDENT: You have heard the motion, gentlemen. Do you wish it to be read a second time? If not, what is your pleasure? All in favor of it say "aye"——

MR. BARR: Mr. Chairman, are we prepared to vote intelligently on that just now? I do not believe I am quite; there is possibly another side, and is there anybody here to present the other side?

THE PRESIDENT: Let us read it again if you please, then: "Moved, That the Secretary, on behalf of the Association, send to the heads of motive power departments a circular letter containing a summary of this report, requesting them to use their best efforts to have a specification for wrought-iron pipes, including the table of dimensions, and in line with the action of this Association, adopted as standard." Now as I understand it, the object of that is that every man may be familiar with the action of this Association. It does not

make it obligatory on his part to order such material. But he may know, and he will not have any excuse for ignorance.

MR. LAWRENCE: If I understand this thing rightly, which I do not suppose I do, would it not be reasonable or proper for this Association or this committee to furnish the members of this Association with a specification, so that they can present that to their purchasing departments?

THE PRESIDENT: That is included in the motion.

MR. QUEREAU: It is simply to provide the members of the Association — that is, the heads of motive power departments and the purchasing agents through whom they buy their supplies—with a table giving the Briggs standard threads for wrought-iron pipes as determined by the Pratt & Whitney gauges. That is all there is to it. It says nothing as to the quality of the pipe or where it shall be bought—simply that they shall have the table of the Briggs standard, which we have just adopted, in their possession, and if they approve of the action of this convention they certainly will urge on their supply department the adoption of this table, which simply gives the standard threads.

THE PRESIDENT: You did not understand it that way before, did you, Mr. Barr? Or is there still an objection to that?

MR. BARR: We don't know what the other standard is. I think it is all right; only we are voting in considerable ignorance.

THE PRESIDENT: There is not any other standard, we understand, from this.

MR. BARR: I guess it is all right.

THE PRESIDENT: All in favor say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: Mr. Atkinson, are you ready to report for the Committee on Subjects? Is Mr. Hickey in the room? I see Mr. Henderson is here, the only member of the committee. I guess he will have to read the report.

MR. HENDERSON: I do not know that there is anything to be said. The subjects speak for themselves. The topical discussions have already been handled very largely, and the subjects for committee work are given. Nine subjects are named; some of those subjects, of course, hanging over, which I suppose we will have to eliminate. That of course is generally done at the discretion of the

Executive Committee. I hardly think it is necessary to read these subjects out unless you so desire. They are printed, and the members all have them before them. There is hardly any room for discussion on this matter.

Following is the report of the Committee on Subjects:

To the President and Members of the
American Railway Master Mechanics' Association:

The committee appointed to submit subjects to be reported upon at the convention in June, 1900, respectfully presents the following:

FOR COMMITTEE WORK.

1. The proper relation between diameter and stroke of cylinders in various types of locomotives for various classes of service.

2. Maximum ratio between tractive force and weight available for adhesion in various types of locomotives and for various classes of service.

3. Latest type of piston valves. Their economy in repairs on the locomotives and difference in cost of repairs to valves.

4. How to test lubricating oils and various bearing metals in regard to wear of journals and cylinders.

5. The relative economy and efficiency of hydraulic versus pneumatic riveting for boilers.

6. Relative cost of power transmission by shafting versus electricity.

7. Best type of stationary boilers for shop purposes, with reference to different kinds of coal and water.

8. Superheated steam and its economy for use in stationary engines, and is it practicable to arrange similar apparatus for locomotive service?

9. Present status of compound locomotives, and what is the best ratio of cylinders for various classes of locomotives and service?

MR. SANDERSON: I make the motion that the report be received and the subject for committee work be referred to the Executive Committee.

The motion was carried.

THE PRESIDENT: Gentlemen, suppose you turn to page 5 of your programmes; you will find there topical discussion No. 8: "What can be done to thoroughly relieve the vacuum in the low-pressure cylinder in a compound locomotive when drifting." Mr. Sinclair will kindly open up this topical discussion.

MR. ANGUS SINCLAIR: Mr. President, I was troubled yesterday with remorse of conscience, from the fact that I thought I was talking a great deal too much, and occupying the time of the convention somewhat unjustifiably. I do not think I am going to

occupy your attention too long on this subject. I think it might as well have been widened to take in all engines with large cylinders. Ever since cylinders up to about twenty inches began to come into use there has been more or less trouble with the vacuum in the cylinder when drifting, and great trouble from the action of the vacuum on the fire. The stereotyped method of overcoming that has been the relief valves. As far as I can judge, relief valves have been thoroughly tried and found wanting. A very great objection to them is that they are nearly always leaking when the engine is working steam, and it is a very great source of annoyance, and to some extent danger, the steam blowing up there in front and obscuring the view of the engineman. That device having been thoroughly tried and being unsatisfactory, some parties have tried the use of by-pass valves and passages. That is not anything new. One of our oldest members, Reuben Wells, used a by-pass on engines made thirty or forty years ago, and found them quite satisfactory. There was not such a great necessity for them as that time as there is now, and as far as I have seen the by-pass is bound to come for future large engines, and what I have examined of that, and what I have seen of its working, causes me to think that is the most satisfactory solution of the difficulty.

THE PRESIDENT: Are there others? Mr. Mellin, let us hear from you, if you have anything to say on this subject.

MR. MELLIN: With the compounds we made our tests on a comparatively level road. We anticipated that we should get some trouble from the pumping action of the low-pressure cylinder. As we did not discover any trouble on the first tests we made, we postponed for some time the application of any device that would do away with that effect. But shortly after that we made tests on different roads, we struck hill work and had trouble, and then we applied the device — I think it is what Mr. Sinclair referred to — the by-pass valve. This has shown considerable improvement and we can increase this valve to any size desired without increasing the clearance in the cylinder portion to any mentionable extent. We have had several tests made at very high speed down grade. We have found that with and without this valve there is a difference of about sixty to seventy per cent reduction in the back pressure of the piston as well as a reduction on the suction side. As soon as the throttle is shut off, the suction in the steam chest upon those valves instantly opens a direct

connection with both ends of the cylinder. When the throttle again is opened it closes the valve in the same way by steam pressure behind it. By this application we have removed, so far as I can see, any trouble. There is no trouble whatever with the working of those valves if they are looked after occasionally to see that no grit or cinders get into them.

MR. SANDERSON: In my opinion the best by-pass or relief valve is the throttle. Have your throttle open and you will not get any vacuum, and you will save the lubrication of the cylinders and valves at the same time.

MR. GILLIS: I can indorse what Mr. Sinclair said about the by-pass valves with large pistons. It is our effort to simplify the compound engine as much as possible, and I felt that a by-pass valve was possibly an unnecessary addition. We wanted to do away with it if we could. We made some tests on the C. & O. road on one of their engines. They very kindly allowed us to take and rig the engine so that we could cut the by-pass out or in at will, and we found the greatest amount of difference between the by-pass valve cut out and cut in, and I think it is absolutely necessary to large cylinders.

MR. MORRIS: Mr. President, I think the by-pass valve is about the only way by which you can accomplish this. I can hardly agree with Mr. Sanderson that the open throttle is the only thing that will overcome the vacuum in the low-pressure cylinder. When we started with the compound several years ago, in 1892, this was really not thought of, and after we had built a good many heavy engines and put them into the mountains, we found that the hill service required almost as much coal to go down hill as it did to go up. But since the introduction of the by-pass valve — and I can say there has been considerable experimenting in that direction before this one that we have now developed — we have had a great deal less trouble. There is a trifle of an objection that exists now and we find that we get greater economy from our compound engines by using them in districts where we do not have to close the throttle at all in our very little drifting. We show a development of at least twenty to twenty-two per cent economy in fuel without any additional cost for repairs in the level districts. But in the mountain districts where these by-pass valves were not applied to the engines the per cent of economy rarely ran over eleven. After applying these by-pass valves it increased, and the saving with the simple engines was about between fourteen and

fifteen per cent, but not as great, as a whole, as on the more level districts.

THE PRESIDENT: Are there others who wish to speak? If not, the subject is closed. The next subject is No. 11: "Is it advisable or not, under any circumstances, to use bars in exhaust nozzles? What are the advantages and disadvantages?" This was to be opened by Mr. William McIntosh, of the Central Railroad of New Jersey, but he had to go away and he has left a communication with our Secretary, Mr. Cloud.

MR. CLOUD: Mr. McIntosh asked me to read this communication at this time:

While the use of bars or bridges in exhaust nozzles is not generally advisable, I have known cases where an enterprising engineer has succeeded in getting steam by putting a bar in a poorly proportioned nozzle after other means had failed. Putting a bridge in the nozzle simply spreads the exhaust sufficiently to partially fill a smoke stack that otherwise would not be filled. Better results would follow a change in diameter or height of nozzle and allow the retention of the annular form, which experience has demonstrated is best adapted for all kinds of jets and nozzles. The application of a bridge to a nozzle so proportioned that the escaping steam and gases would nearly fill the stack at its base, would cause the exhaust to spread, strike the smoke arch and react, thus interrupting the draft. It would therefore seem that the practice should be condemned as unskillful and only productive of results better obtained from more approved methods.

MR. QUEREAU: I may add just a word which I happen to be in position to do. In reply to circular letters of the International Committee on the subject of exhaust pipes and front ends, out of twenty replies received, nineteen said that under no circumstances did they allow a bridge in the exhaust tip. The remaining reply said it was allowed to be used only in emergency cases, showing that so far as heads of departments are concerned they condemned the use of the bridge.

MR. MANCHESTER: Mr. President, I am surprised that a subject of this kind should come before the convention. I do not believe that there is a mechanical man in this country who considers that the method proposed or the method referred to is a mechanical method. It is simply a makeshift, and I would think it just as proper to bring before this convention the question of whether we should rivet over the end of our rod bolts to keep the nuts from falling off.

MR. MCCONNELL: Mr. Chairman, I move that it is the sense

of this Association that it is not advisable to use bars in exhaust nozzles.

MR. MORRIS: I second the motion.

THE PRESIDENT: Gentlemen, you have heard the motion, that it is the sense of this Association that it is not advisable to use bars in exhaust nozzles. Are there any remarks on the motion? All in favor of the motion say "aye"; contrary minded, "no."

The motion was carried.

THE PRESIDENT: That closes the discussion, I think. The next subject is No. 12: "Is there sufficient prospective economy to be derived from heating the feed water for locomotives, and how can it be most reliably fed to boilers?" Mr. Garstang is not present, is he? The Secretary has a communication from Mr. Garstang which he will read.

Mr. Cloud read the following communication from Mr. Garstang:

In opening the discussion relative to the "Prospective economy to be derived from heating the feed water for locomotives, and the most reliable way it can be fed to boilers" deals with a subject, it seems to me, in which our possibilities are limited to practically what we are now doing.

We realize the benefits of high temperature feed water, when the high temperature can be obtained without the expense of burning any fuel to obtain it, but at that point economy ceases, as our boilers are better arranged to utilize the heat value of the coal burned than any arrangement we are likely to make possible for heating feed water before it enters the boiler.

Any arrangement that can be perfected to utilize the waste or escape steam to raise the temperature of the feed water will be a benefit in direct proportion to the increased temperature, less the retarding effects on the parts furnishing the heat and the maintenance of the apparatus employed, but so long as it is necessary to use a reduced exhaust nozzle, and the powerful blast it creates to maintain steam in the locomotive boiler, it does not seem practical to utilize any of the lost heat from this source, and which is the only available one to materially increase the temperature of the feed water.

The heat imparted to the water passing through the injectors, while robbing the boiler of some steam, imparts its total heat to the water fed, which can not be considered a loss, and is probably the most practical and economical way the question can be handled.

In conclusion, it seems there are only two practical ways of getting any beneficial results; one by utilizing the air pump exhaust through a coil in the tank, and the other by utilizing any over pressure in the boiler by turning it into the tank through the injector heater.

MR. DAVID BROWN: Inasmuch as the injectors are being principally used now, I think that it settles the matter of heating the feed water. We can not possibly get the water very warm as it would interfere with the working of the injector, and that naturally heats the water to a good temperature. I think that the feed-water heater is a thing of the past. It is very well where we are using pumps.

MR. LAWRENCE: In connection with this matter of heating feed water for locomotive boilers I think that we shall probably be called upon sooner or later to take some definite action in regard to it. You all know that we have been requested from time to time to undertake by various means and methods to abolish as far as possible the smoke nuisance — by using good coal or by educating our firemen, and so forth, and I think it is not unreasonable to suppose that we may be expected to make invisible, if you please, the escaping steam from locomotive poppet valves in spite of the fact that we are using today almost universally a muffle valve. On railroads having a large local traffic—especially where the track runs through the principal street of a town—we all know that accidents have happened by horses being scared by escaping steam, and I think it is reasonable for us to take up this question and consider it about turning the escaping steam from the boiler as well as the exhaust from the air pump into the locomotive tank, and I also believe, when the time comes to do that, that the manufacturers of the instruments providing for putting the water into the boiler will be ready to meet us with one that will handle the water no matter how hot you get it, within reasonable limits.

PROF. H. WADE HIBBARD: In reference to what Mr. Brown said about injectors using the hot water, I would say that there are some makes of injector which will feed much hotter water than other makes.

MR. C. H. QUEREAU: I dislike to thrust myself on the convention, but I am in a position, for the reason that I gave in my last remark, to have some information that may be of interest. Of these same twenty replies to which I have just referred, nineteen said they had done nothing with this subject. One said that they were now building a device by which they hoped to save some heat in the tender from the exhaust. The C. B. & Q. has fitted up a couple of switching engines in Chicago with an independent pump on the boiler head on the left side, and the injector on the right side, the pump to

be used in delivering water when it was so hot that the injector could not handle it. We have recently made some tests on the road with which I am connected showing that injectors with closed overflows—not any specific kind of injector, but two kinds, one of which made a special claim for delivering hot water, the other did not — the injectors with closed overflows would deliver water into the boiler at a temperature of about 126 degrees, but their range of action is considerably limited, and the amount of water which they supply is considerably less as it becomes warmer. It occurs to me that possibly the arrangement used experimentally now by the Burlington of having an independent pump on the boiler head for one side of the engine has the promise of some saving.

MR. DAVID BROWN: The only trouble would be that if the pump should give out, what would become of the injector?

MR. ANGUS SINCLAIR: Mr. President, this question of heating feed water for locomotives is about as old as the locomotive itself. It comes up periodically, I think, about every decade. Sometimes it has been up very strongly, indeed. About twenty years ago it was very virulent on the Rock Island Railroad. I was employed not far away from there at that time, and there were great claims made for the saving effected. The fact of the matter is that people go into that enthusiastically without understanding how small the saving is. With the maximum of heat you can put into the tender, about the best you can do is one per cent for every ten or twelve degrees of heat. You can not put much more than thirty degrees of extra heat in the feed water; yet I have heard claims of ten and fifteen and twenty per cent saving. I ran an engine for two or three years with a heater on it for which great claims were made, and there was never anything of that kind got a better show than that did with me, and about the best that I could have it do was to heat the water to about 110 degrees. The injector would not work above that. It took a part of the steam from the exhaust, and conveyed it back into the tender. A great many inventions of that kind have been brought out where a part of the exhaust was turned into the tender. I think that all those inventions are going the wrong way. There is nothing can be spared from the exhaust steam if you are to use it for fanning the fire. Every pound of steam that you take away from the air is to be accounted for by the reduction of exhaust nozzles. So it is a wrong principle to take the steam from the air. However, that has

been tried very often, and my experience with this engine was that you would fill up the water tank and there was no extra heat at that time to speak of. I carried a thermometer with me and paid a great deal of attention to the exact heating I was able to give the water. By the time the engine ran perhaps ten miles, the water would get up ten or fifteen degrees; it very rarely got up more than twenty degrees before we got to the next water tank, and cooled down again. The consequence was that while the inventor of the apparatus thought that we were always running with water of 100 or 110 degrees, we were really running about the average between 100 and the temperature of the feed water. I think that I have looked upon that subject with as little prejudice as any man that has made investigations in regard to the mechanical working of locomotives. I believed in it at first, and it was only by experience and experiment that I was convinced that I was mistaken. Now I think that whatever can be done in the way of feed-water heating produces so little economy that the expense of keeping the apparatus in order, applying and so on, overcomes whatever saving you can have from the heating. The only advantage that I could ever see from putting steam into the tender was that in winter it keeps down what is spoken of as sweating, that is, the water in the air condenses on the outside of the tender, making the paint flabby and soft. It does that and keeps a nice looking tender. But otherwise I can see no use for turning steam into the tender.

THE PRESIDENT: Are there any further remarks? The subject is closed. We will now take up the eleventh order of business, which is routine and miscellaneous business. I will call for the report of the Committee on Correspondence and Resolutions. Mr. Soule, are you ready to report?

MR. R. H. SOULE: The Committee on Resolutions presents the following report:

In acknowledgment of the disinterested efforts of those who have contributed to the great success of the Thirty-Second Annual Convention of the American Railway Master Mechanics' Association, it is

Resolved, That the thanks of the Association and of its members are due—

To the Rev. Mr. Walke for his services at the opening session.

To the Hon. Joseph Bryan, President of the Richmond Locomotive Works, and to Capt. Robley D. Evans, of the United States Navy, for their able and interesting addresses.

To Mr. W. S. Morris, Superintendent of the Motive Power of the Chesapeake

& Ohio Railway for his untiring efforts as business representative of the Committee of Arrangements.

To the Supply Men's Association for its plan of entertainment arranged and carried through with such admirable good judgment and discretion.

To the *Railway Age* and its representatives, for their completely satisfactory work in publishing daily the proceedings and news of the convention.

To the Chesapeake & Ohio Railway, the Norfolk & Western Railway, the Pullman Palace Car Company, and the Wagner Palace Car Company, for transportation facilities and for the personal courtesies of their representatives here present.

To our president and officers for the able manner in which the business of the Association has been conducted during the year and at this convention.

Respectfully submitted,

R. H. SOULE,
A. E. MITCHELL,
JOHN HICKEY,
Committee.

THE PRESIDENT: Gentlemen, you have heard the report of the Committee on Resolutions. What is your pleasure?

MR. SINCLAIR: I move it be received. (Seconded.)

MR. MCCONNELL: Mr. Chairman, I would ask Mr. Soule, as chairman of that committee, if he will not kindly insert the Wagner Palace Car Company in that report. I did not hear that.

MR. SOULE: Mr. President, I do not feel at liberty to do so on my personal responsibility, and I would prefer that that should be acted upon by the convention.

MR. MCCONNELL: I move, as an amendment to the report, that the name of the Wagner Palace Car Company be added.

MR. DAVID BROWN: Should not the Pullman Company be added as well?

THE PRESIDENT: The Pullman Company is mentioned.

MR. SMALL: Will the mover of the amendment kindly state the reason for offering it?

THE PRESIDENT: The idea is this — the Pullman Palace Car Company is in the resolution; they are spoken of creditably. Mr. McConnell says that the Wagner Palace Car Company had a representative here also who was furnishing transportation to those who desired it. I did not know it.

MR. PECK: It was not so announced.

A MEMBER: I could not find him.

THE PRESIDENT: What is the pleasure of the convention concerning the amendment?

MR. BROWN: I move that the remarks of Mr. McConnell be indorsed in the matter.

THE PRESIDENT: The motion has been seconded. You know what the amendment is. All in favor of the amendment say "aye"; opposed, "no."

The motion was carried.

THE PRESIDENT: Now the original question as amended. All in favor of the resolution as it now stands say "aye"; opposed, "no."

The resolutions were adopted.

THE PRESIDENT: The Secretary has some announcements to present to the convention.

MR. CLOUD: A letter from the Secretary of the Navy, under date of May 17, to Mr. Quayle, the President of the Association:

SIR,— The receipt is acknowledged of your letter of the 15th inst. requesting the detail of a man-of-war to be present at Old Point Comfort from June 14 to 21, during the conventions of the Railway Master Mechanics' and Master Car Builders' Associations. The Department regrets exceedingly that it is compelled to refuse this request, as it has those of other officers of your Association for the same detail. During the period fixed for the convention the ships of the North Atlantic Squadron which can be spared from active duty on the coast of Central America will be engaged on a programme of drill instruction which can not be interrupted without serious detriment to the service. Very respectfully,

JOHN D. LONG, *Secretary.*

THE PRESIDENT: If there is no objection we will place that on file without further action. The Secretary has nothing else except some communications concerning the next meeting. Do you wish to take those up now or shall we proceed with the election of officers. Does any one have anything to say about the place of the next meeting?

MR. SINCLAIR: I move the correspondence relating to the place of the next meeting be referred to the joint Executive Committee.

The motion was carried.

THE PRESIDENT: I did not hear any member say where they wanted to go next year. Any preferences?

The next order of business, gentlemen, is the election of officers. That requires the appointing of tellers. I will ask Mr. W. H. Lewis

and Mr. Lang of Chattanooga to act as tellers. The By-laws provide for only two.

MR. WEST: It has not been announced how we were to vote.

THE PRESIDENT: By ballot. The first vote is for the President of the Association and by ballot.

MR. GILLIS: I think, as a matter of information — some of the members may be as ignorant as I am as to exactly who the present officers of the Association are.

THE PRESIDENT: The Secretary will read the names of the present officers.

MR. CLOUD: Mr. Robert Quayle is President of this Association; the First Vice-President is Mr. J. H. McConnell; the Second Vice-President is Mr. W. S. Morris; the Third Vice-President is Mr. A. M. Waitt; the Treasurer is Mr. J. N. Barr.

The convention proceeded to ballot for President.

THE PRESIDENT: I might say, gentlemen, that I have received a dispatch from Mr. Waitt. The day before yesterday he went to New York and he intended to come back, but he said that some matters came up in New York City which prevented his coming back. He regretted it very much. The tellers will proceed to collect the ballots. Gentlemen, while the tellers are counting the ballots for President, you might as well be preparing your ballots for First Vice-President. I might say to you that the Second Vice-President last year was Mr. W. S. Morris.

MR. LEWIS: I have to announce that there are 38 ballots deposited — 30 for Mr. J. H. McConnell; 4 for Mr. Robert Quayle; 1 for Mr. W. S. Morris; 1 for Mr. A. M. Waitt; 1 for W. E. Symons; 1 for J. N. Barr.

MR. SINCLAIR: I move that the vote for Mr. McConnell be made unanimous.

THE PRESIDENT: Gentlemen, the motion is that the vote for Mr. J. H. McConnell for President of this Association be made unanimous. All in favor of that please rise to their feet. It is unanimous. I take pleasure in introducing to you the new President of the Association, Mr. J. H. McConnell. (Applause.)

MR. MCCONNELL: Mr. Chairman and Gentlemen,— I thank you very much for your kindness and consideration in electing me to

serve you for the ensuing year. It is an honor which I very much appreciate, and with your kind forbearance and assistance I hope to serve you the next year to the best of my ability. (Applause.)

MR. QUAYLE: Gentlemen, before giving the gavel into the hands of our newly elected President, I will take this opportunity to say just a few words. First, I think that you are subjects of congratulation because of the propitious weather that we have had for the conduct of our business; secondly, for the able reports that have been presented here, and the manner in which they have been discussed. And I want to thank the officers and members of the Association, and members of committees, for the manner in which they have assisted in bringing about the results that have been presented to this Association. The President indeed has had but very little to do with the matter, except as a director in some little things. The Secretary has so ably conducted the affairs of the Association that the President has had little to do, and no man need be afraid to take hold of the work in the Association as President with such able men about him. I therefore feel that I am a subject for congratulation for having such excellent men with me. I thank you for your attention throughout the entire session, and for your attendance here, and I hope that you will give to the succeeding officers — I do not need to say I hope, for I know that you will — the same help that you have given to me. Mr. McConnell, will you take the chair now? (Applause.)

President McConnell then took the chair.

THE PRESIDENT: Gentlemen, the next order of business is the election of First Vice-President. Will the tellers please collect the ballots. Have all the gentlemen voted? If so, I declare the ballot closed.

MR. LEWIS: Mr. President, I have the pleasure of announcing a unanimous vote for W. S. Morris, with the exception of one vote for Mr. Barr, that he cast himself. (Laughter and applause.)

THE PRESIDENT: Mr. Barr, will you kindly make a motion to make the election of Mr. Morris unanimous?

MR. QUAYLE: I move that Mr. Barr explain why he voted for himself.

MR. BARR: I do not like to say which way I voted. But I am put in rather a false position. However, I make the motion that this vote for Mr. Morris be made unanimous.

THE PRESIDENT: It has been moved and seconded that the election of Mr. Morris be made unanimous. All in favor signify it by rising.

The motion was unanimously carried.

MR. MORRIS: Gentlemen, I thank you very much for this honor. I am going to clear the atmosphere which Mr. Barr was a little timid about doing and acknowledge that I voted for Mr. Barr. I think that we have done no more than our duty to this Association in helping our President this year, and I thank not only the Association but all who have assisted in making it pleasant here. Of course, this is a place where we are supposed to do a little more work than if the meeting was in some other fellow's territory. But I feel that everybody at this meeting has contributed his share to making it a success. I thank you as members of the Association for my promotion. (Applause.)

THE PRESIDENT: Please prepare your ballots for Second Vice-President.

The convention proceeded to ballot for Second Vice-President.

THE PRESIDENT: Have all the gentlemen voted? If so, I declare the ballot closed.

MR. SOULE: While the ballot for Second Vice-President is being counted I would like to ask whether there is anything in the Constitution or By-laws which would make it impossible for one and the same individual to hold the positions of Third Vice-President and Treasurer.

THE PRESIDENT: That is a question I think the Secretary might answer.

MR. CLOUD: I do not think it is said so in words, but I think it is fairly to be concluded by inference from the language contained in the Constitution that the officers of the Association shall be a President, three Vice-Presidents and a Treasurer, and the number of officers is recognized in another part where it is said that the five officers of the Association as thus constituted shall, with five members of the Executive Committee of the Master Car Builders' Association, form a joint committee on selection of the place of next meeting. It is therefore clear from all that is contained in the Constitution, as I recollect it, that the Treasurer is supposed to be a separate entity, so to speak.

THE PRESIDENT: Mr. Soule, I should consider, after hearing Mr. Cloud's remarks on that subject, that the Third Vice-President and the Treasurer should be two distinct persons, and I believe it would

be not in accordance with the rules of the Association to elect the Treasurer as Third Vice-President.

MR. DAVID BROWN: I think the matter would take care of itself, Mr. President.

MR. SOULE: Of course, your ruling leaves the membership the privilege of voting for Mr. Barr for Third Vice-President if they so desire.

THE PRESIDENT: No, sir, I would not wish the members to consider it in that light.

MR. BROWN: What I mean is if Mr. Barr is elected Third Vice-President we can elect another Treasurer; that is all.

THE PRESIDENT: Will you please state your question again, Mr. Soule?

MR. SOULE: I said I take it that your ruling still left the matter in such shape that it was the privilege of the members to vote for Mr. Barr as Third Vice-President if they so desire.

THE PRESIDENT: Yes, sir; it is certainly so.

MR. LEWIS: I have to report the result of the ballot for Second Vice-President. Forty-four ballots were cast; 33 for Mr. A. M. Waitt, 10 for Mr. J. N. Barr, 1 for Mr. Peter Peck.

THE PRESIDENT: Gentlemen, you have heard the result of the ballot, which is that Mr. Waitt is elected to this Association for the next year as Second Vice-President.

MR. SINCLAIR: I move that the election be made unanimous.

THE PRESIDENT: As many as are in favor of the motion will signify by rising. The motion is carried, and Mr. Waitt is elected unanimously. Gentlemen, please prepare your ballots for Third Vice-President.

The convention then balloted for Third Vice-President.

THE PRESIDENT: Have all the gentlemen voted? If so, I declare the ballot closed.

MR. LEWIS: Mr. President, I have to announce that we have a total of 42 ballots cast, of which Mr. Barr receives 35; Mr. Brown, 1; Mr. Hibbard, 1; Mr. Humphrey, 1; Mr. Small, 1; Lewis, 1; Mr. Joughins, 1.

THE PRESIDENT: Gentlemen, by your ballot, you have elected Mr. Barr to serve you for the ensuing year as Third Vice-President.

MR. SANDERSON: I move that the vote be made unanimous.

THE PRESIDENT: All in favor signify by rising. It is unanimously carried. (Applause.) Mr. Barr, will you kindly address the convention?

MR. BARR: Mr. Chairman, I can not make a speech. I will do what I can, gentlemen, to fulfill the duties of the position, and I thank you for the honor you have conferred.

THE PRESIDENT: Gentlemen, please prepare your ballots for Treasurer. I wish to say, in this connection, that by your ballot you have decided you do not wish Mr. Barr to continue any longer as Treasurer of this Association. (Laughter.)

The convention proceeded to ballot for Treasurer.

THE PRESIDENT: Have all the gentlemen voted? If so, I declare the ballot closed.

MR. LEWIS: I have to announce that a total of 35 ballots were cast, of which T. R. Brown receives 1; W. H. Lewis, 10; C. H. Quereau, 5; L. R. Pomeroy, 4; Angus Sinclair, 4; George W. West, 15; Peter Peck, 2; H. J. Small, 1; R. H. Soule, 1; David Brown, 1; A. L. Humphrey, 1; S. P. Bush, 1.

THE PRESIDENT: Gentlemen, there is no election and you will again prepare your ballots for Treasurer.

MR. PECK: Is it not limited now to the two highest? Is not that the by-law?

THE PRESIDENT: It is a custom but not a law. It is for the Association to decide that. It is a privilege which the Association has to drop the lowest number of votes and select the highest number. Mr. Secretary, will you call out the three highest numbers?

MR. CLOUD: The three that received the highest number of votes were G. W. West, 15; W. H. Lewis, 10; and Mr. Quereau, 5.

A second ballot was then taken for Treasurer.

THE PRESIDENT: Have all the gentlemen voted? If so, I declare the ballot closed.

MR. LEWIS: Mr. President, I have to announce that 33 ballots were cast, of which Mr. George W. West receives 22; W. H. Lewis, 18; C. H. Quereau, 3.

THE PRESIDENT: Gentlemen, by your ballot you have elected Mr. West to serve you as Treasurer for the ensuing year. Will Mr. West please come forward.

A MEMBER: I move that the election be made unanimous.

THE PRESIDENT: All in favor of that signify by rising. It is a unanimous vote. (Applause.)

MR. WEST: Gentlemen, I need not tell you that I can not make a speech. I think you have all listened to my attempts to express myself on the floor of these conventions, and that you are well satisfied that I can only thank you for the great honor conferred. (Applause.)

THE PRESIDENT: Gentlemen, this finishes up the business of the Association, unless some member has something to offer. If not, a motion to adjourn will be in order.

MR. MILLER: I move that we adjourn.

The motion was seconded by Mr. Brown, and carried.

THE PRESIDENT: This convention is now adjourned.

STANDARDS ADOPTED BY THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

SCREW THREADS.

At the Third Annual Convention the report of a committee recommending the United States standard screw thread was adopted. Annexed are the forms and dimensions of the threads in question.

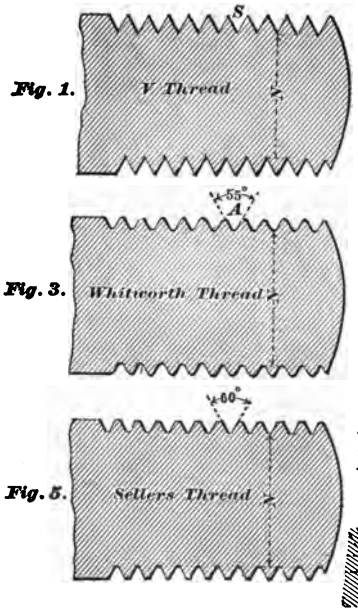


Fig. 1.

Fig. 3.

Fig. 5.

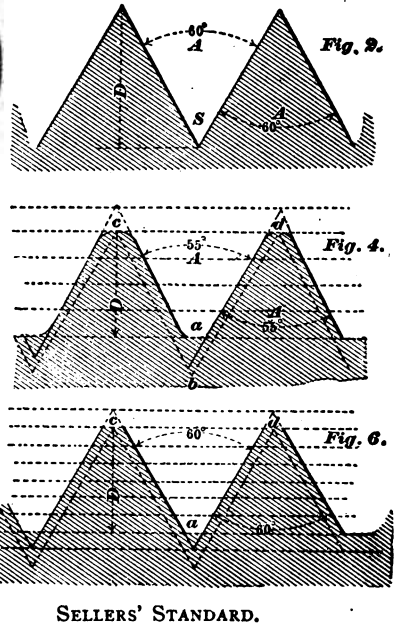


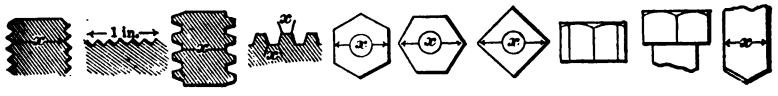
Fig. 2.

Fig. 4.

Fig. 6.

SCREW THREADS. SELLERS' STANDARD.

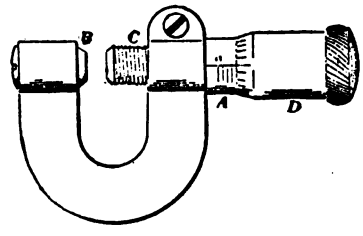
The Association at the Twenty-fifth Annual Convention adopted the United States standard sizes of nuts and bolt heads, particulars of which are given below:



Diameter of Screw.	Threads per inch.	Diameter at Root of Thread.	Width of Flat.	Short Diameter of Hexagon or Square.	Long Diameter Hexagon.	Long Diameter Square.	Thickness Nuts.	Thickness Heads.	Tap Drl 1.
1/4	20	.185	.0062	1/2	27/64	7/10	1/4	1/4	13/64
5/16	18	.240	.0074	19/32	1/2	45/64	5/16	1/4	17/64
3/8	16	.294	.0078	11/16	37/64	1	3/8	5/16	5/16
7/16	14	.344	.0089	25/32	43/64	1 1/64	7/16	11/32	3/8
1/2	13	.400	.0096	7/8	1	1 9/64	1/2	13/32	27/64
9/16	12	.454	.0104	31/32	1 1/8	1 9/32	9/16	7/16	31/64
5/8	11	.507	.0113	1 1/16	1 7/32	1 1/2	5/8	15/32	17/32
3/4	10	.620	.0125	1 1/4	1 7/16	1 49/64	3/4	9/16	5/8
7/8	9	.731	.0138	1 7/16	1 21/32	2 1/32	7/8	5/8	3/4
1	8	.837	.0156	1 5/8	1 7/8	2 19/64	1	11/16	27/32
1 1/8	7	.940	.0178	1 13/16	2 3/32	2 9/16	1 1/8	25/32	31/32
1 1/4	7	1.065	.0178	2	2 5/16	2 53/64	1 1/4	7/8	1 1/32
1 3/8	6	1.160	.0208	2 1/16	2 7/32	3 3/64	1 3/8	15/16	1 3/16
1 1/2	6	1.284	.0208	2 3/8	2 3/4	3 13/64	1 1/2	1 1/16	1 19/32
1 5/8	5 1/2	1.389	.0227	2 9/16	2 31/32	3 5/8	1 5/8	1 3/32	1 23/32
1 3/4	5	1.491	.0250	2 3/4	3 3/16	3 57/64	1 3/4	1 3/16	1 1/2
1 7/8	5	1.616	.0250	2 15/16	3 13/32	4 5/32	1 7/8	1 5/16	1 5/8
2	4 1/2	1.712	.0277	3 1/8	3 5/8	4 27/64	2	1 7/16	1 3/4
2 1/4	4 1/2	1.962	.0277	3 1/2	4 1/16	4 61/64	2 1/4	1 3/4	1 31/32
2 1/2	4	2.176	.0312	3 7/8	4 1/2	5 31/64	2 1/2	1 15/16	2 3/16
2 3/4	4	2.426	.0312	4 1/4	4 29/32	6	2 3/4	2 1/8	2 7/16
3	3 1/2	2.629	.0357	4 5/8	5 3/16	6 17/64	3	2 5/16	2 5/8
3 1/4	3 1/2	2.879	.0357	5	5 13/16	7 1/16	3 1/4	2 1/2	2 29/32
3 1/2	3 1/4	3.100	.0384	5 3/8	6 7/16	7 53/64	3 1/2	2 11/16	3 1/32
3 3/4	3	3.317	.0413	5 3/4	6 29/32	8 1/8	3 3/4	2 7/8	3 11/32
4	3	3.567	.0413	6 1/8	7 3/16	8 41/64	4	3 1/16	3 15/32
4 1/4	2 7/8	3.798	.0435	6 1/2	7 9/16	9 1/16	4 1/4	3 1/4	3 1/16
4 1/2	2 3/4	4.028	.0454	6 7/8	7 29/32	9 3/4	4 1/2	3 7/16	4 3/32
4 3/4	2 5/8	4.256	.0476	7 1/4	8 1/32	10 1/4	4 3/4	3 5/8	4 9/32
5	2 1/2	4.480	.0500	7 5/8	8 7/32	10 49/64	5	3 13/16	4 1/2
5 1/4	2 1/2	4.730	.0500	8	8 29/32	11 25/64	5 1/4	4	4 3/4
5 1/2	2 3/8	4.953	.0526	8 3/8	9 5/32	11 7/8	5 1/2	4 1/16	4 23/32
5 3/4	2 3/8	5.203	.0526	8 3/4	10 5/32	12 3/8	5 3/4	4 3/8	5 7/32
6	2 1/4	5.423	.0555	9 1/8	10 29/32	12 1/16	6	4 9/16	5 1/16

SHEET METAL GAUGE.

At the Fifteenth Annual Convention the Brown & Sharpe micrometer gauge shown below was adopted as standard for the measurement of sheet metal.



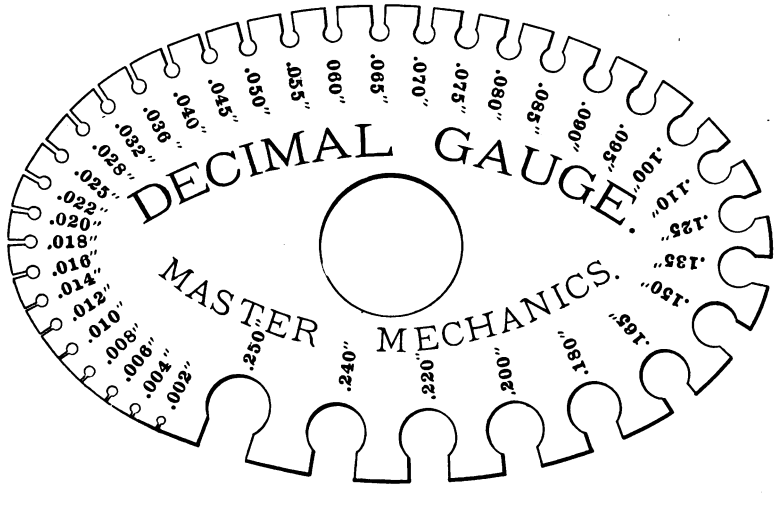
DECIMAL GAUGE.

At the Twenty-eighth Annual Convention the following was adopted as standard decimal gauge:

1st. The micrometer caliper should be used for laboratory and toolroom work, and in the shop when specially desired.

2d. The solid notch gauge should be used for general shop purposes.

3d. The form of this gauge shall be an ellipse whose major axis is 4 inches, the minor axis 2.5 inches, and the thickness .1 inch, with a central hole .75 inch in diameter.



4th. The notches in this gauge shall be as follows:

.002″	.022″	.060″	.110″
.004″	.025″	.065″	.125″
.006″	.028″	.070″	.135″
.008″	.032″	.075″	.150″
.010″	.036″	.080″	.165″
.012″	.040″	.085″	.180″
.014″	.045″	.090″	.200″
.016″	.050″	.095″	.220″
.018″	.055″	.100″	.240″
.020″	.....	.....	.250″

5th. All notches to be marked as in the above list.

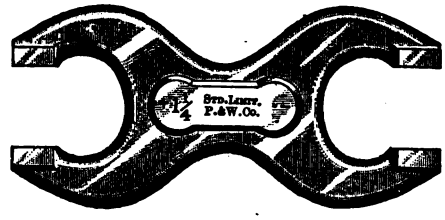
6th. The gauge must be plainly stamped with the words "Decimal Gauge" in capital letters .2 inch high, and below this the words "Master Mechanics."

7th. In ordering material, the term gauge shall *not* be used, but the thickness ordered by writing the decimal as in above list. For sizes over ¼ inch, the ordinary common fractions may be used.

LIMIT GAUGES.

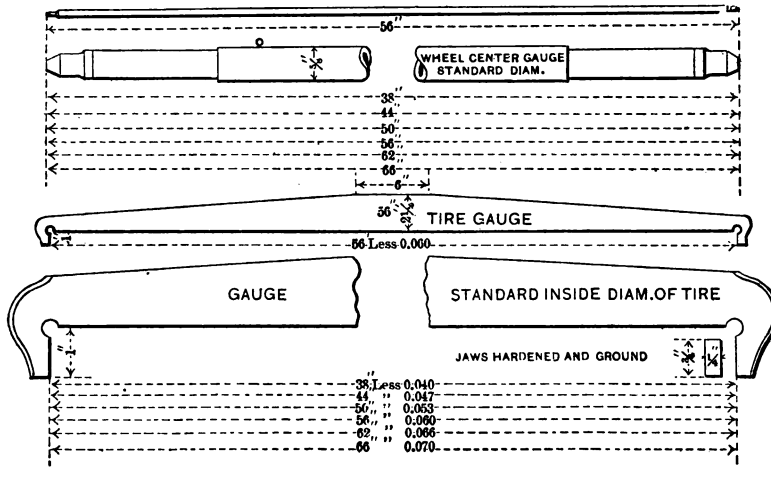
At the Seventeenth Annual Convention the Pratt & Whitney limit gauges for round iron, illustrated on this and following page, were adopted. The sizes are as follows:

Nominal Diameter. Of Iron. Inches.	Large Size, End. Inches.	Small Size, End. Inches.	Total Variation. Inches.
1/4	.2550	.2450	.010
5/16	.3180	.3070	.011
3/8	.3810	.3690	.012
7/16	.4440	.4310	.013
1/2	.5070	.4930	.014
9/16	.5700	.5550	.015
5/8	.6330	.6170	.016
3/4	.7585	.7415	.017
7/8	.8840	.8660	.018
1	1.0095	.9905	.019
1 1/8	1.1350	1.1150	.020
1 1/4	1.2605	1.2395	.021



DRIVING-WHEEL CENTERS AND SIZES OF TIRES.

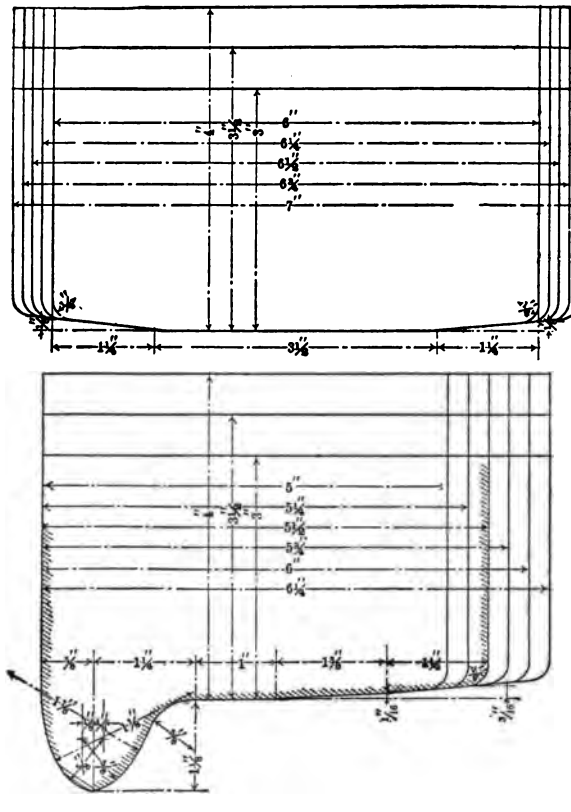
At the Nineteenth Annual Convention the report of a committee was adopted which recommended driving-wheel centers to be made 38, 44, 50, 56, 62 or 66 inches diameter. At the Twentieth Annual Convention the recommendations of a committee were adopted, making tire gauges manufactured by Messrs. Pratt & Whitney, Hartford, Connecticut, and here illustrated, standards of the Association. The sizes and the allowance for shrinkage are as follows:



At the Twenty-sixth Annual Convention the following sizes were adopted as standard for large driving wheels: 70, 74, 78, 82, 86 and 90 inches.

STANDARD FORMS OF TIRES.

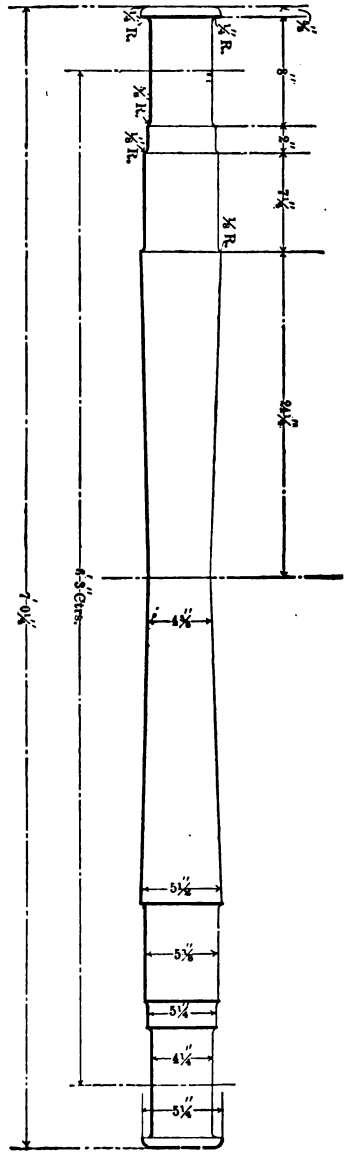
At the Twenty-sixth Annual Convention the forms of tires shown in the annexed engraving were adopted as standard. Railroad companies ordering tires will save time by specifying these forms.



At the Twenty-ninth Annual Convention a minimum thickness of 1 inch for the flanges of engine and truck wheels was adopted as standard practice; determination to be made by M. C. B. flange thickness gauge. See Proceedings for 1896.

AXLE FOR HEAVY TENDERS.

The accompanying illustration shows the dimensions of the axles for heavy tenders recommended by a committee of the Association.



METHOD OF CONDUCTING LOCOMOTIVE TESTS.

Adopted at the Twenty-seventh Annual Convention; full details, page 166, Twenty-seventh Annual Report.

BOILER STEEL SPECIFICATIONS.

Adopted at Twenty-seventh Annual Convention; full details, page 68, Twenty-seventh Annual Report.

SPECIFICATIONS AND TESTS FOR LOCOMOTIVE IRON BOILER TUBES, EXTRA QUALITY.

Adopted at Twenty-eighth Annual Convention.

Material.

Tubes to be made of knobbled hammered charcoal iron and lap-welded.

Dimensions and Weights.

Tubes 2 inches, outside diameter.

.095	inch	thick	and	weight	at least	1.91	lbs. per foot.
.110	"	"	"	"		2.19	" "
.125	"	"	"	"		2.47	" "
.135	"	"	"	"		2.65	" "

Tubes 2¼ inches, outside diameter.

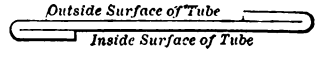
.095	inch	thick	and	weight	at least	2.16	lbs. per foot.
.110	"	"	"	"		2.48	" "
.125	"	"	"	"		2.80	" "
.135	"	"	"	"		3.01	" "

Surface Inspection.

Tubes must have a smooth surface, free from all laminations, cracks, blisters, pits and imperfect welds. They must also be free from bends, kinks and buckles — signs of unequal contraction in cooling or injury in manipulation — and must be of uniform thickness throughout, except at weld, where .015 inch additional will be allowed, perfectly round and cut to exact length ordered.

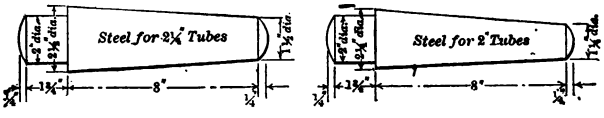
Physical Tests.

1. Strips one-half inch in width by six inches in length, planed lengthwise from tubes, after being heated to a cherry red and dipped in water at 80 degrees Fahrenheit, shall bend in opposite directions at each end as shown in sketch below, without showing cracks or flaws; and when nicked and broken these must show a fracture wholly fibrous, or a test in a testing machine may be substituted for this.



2. Sections of tubes 12 inches long — five inches of which shall be heated to a *bright cherry red* in daylight — when placed in a vertical position, and a smooth-turned tapered steel pin at a *blue heat* is driven in, by "lap" blows with a 10-pound sledge hammer, must stretch to one and one-eighth times their original diameter without split or crack. One tube to be tested, as required in paragraphs 1 and 2, in each lot of 250 tubes or less.

The sketches below show dimensions of steel pins to be used for 2-inch and 2¼-inch O. D. tubes.



3. Tubes must expand, turn over tube plate and bend down without flaw, crack or opening at weld.

Hydraulic Test.

Each tube must be subjected, by the manufacturer, to an internal pressure of 500 pounds to the square inch.

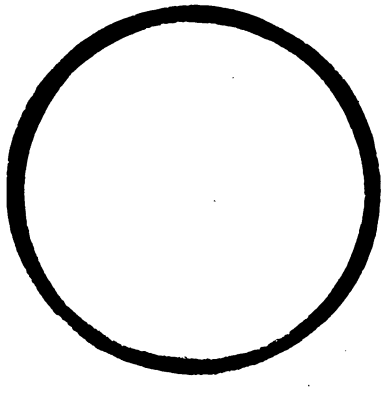
Etching Tests.

In case of doubt as to the quality of material, the following tests shall be used namely:

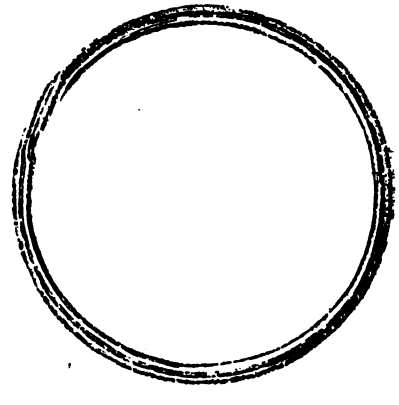
A section of tube turned or ground to a perfectly true surface, polished with fine emery paper, and free from dirt and grease, to be suspended in a bath of

Water	9 parts.
Sulphuric acid	3 "
Muriatic "	1 "

The bath should be prepared by placing the water in a porcelain dish, adding the sulphuric acid and then the muriatic acid. Chemical action is allowed to con-



Steel.



Charcoal Iron.

tinue until the soft parts are sufficiently dissolved so that an iron tube will show a more or less finely ridged surface, with the weld very distinct; a steel tube will present a homogeneous surface.

General Requirements.

Each tube must be plainly stenciled "Knobbled Hammered Charcoal Iron" and "Tested to 500 Pounds," and tubes must be so invoiced. Each tube must also be subjected to careful surface inspection, as provided for above; and those measuring one sixty-fourth of an inch over or under the diameter ordered shall be rejected.

BRIGGS STANDARD WROUGHT-IRON PIPE THREADS.

At the Thirty-Second Annual Convention what is known as the Briggs Standard, as determined by the Pratt & Whitney gauges, of threads for wrought-iron pipe and couplings, was adopted as a standard of the Association.

The gauges used by the Pratt & Whitney Company were made by them from an autograph copy of a table made by Mr. Robert Briggs personally, who originally established and published these standard threads. A copy of it is as follows:

STANDARD DIMENSIONS OF WROUGHT-IRON WELDED TUBES. BRIGGS STANDARD.

Diameter of Tube.			Thickness of metal.	Screwed Ends.	
Nominal inside.	Actual inside.	Actual outside.		Number of threads per inch.	Length of perfect screw.
Inches.	Inches.	Inches.	Inch.	No.	Inch.
⅛	0.270	0.405	0.068	27	0.19
¼	0.364	0.540	0.088	18	0.29
⅜	0.494	0.675	0.091	18	0.30
½	0.623	0.840	0.109	14	0.39
¾	0.824	1.050	0.113	14	0.40
1	1.048	1.315	0.134	11½	0.51
1¼	1.380	1.660	0.140	11½	0.54
1½	1.610	1.900	0.145	11½	0.55
2	2.067	2.375	0.154	11½	0.58
2½	2.468	2.875	0.204	8	0.89
3	3.067	3.500	0.217	8	0.95
3½	3.548	4.000	0.226	8	1.00
4	4.026	4.500	0.237	8	1.05
4½	4.508	5.000	0.246	8	1.10
5	5.045	5.563	0.259	8	1.16
6	6.065	6.625	0.280	8	1.26
7	7.023	7.625	0.301	8	1.36
8	7.982	8.625	0.322	8	1.46
9	9.000	9.688	0.344	8	1.57
10	10.019	10.750	0.366	8	1.68

Tapers of conical tube ends, 1 in 32 to axis of tube. (¾-inch per foot.)

By the late action of the Manufacturers of Wrought-Iron Pipe, 9-inch outside diameter has been excepted from the original list, as above noted, the diameter now adopted being 9.625 instead of 9.688 inches given in the Briggs table.

Obituary.

JOHN R. WAGNER.

Mr. John R. Wagner was born in South Bethlehem, Pennsylvania, on May 12, 1861. His home was one of poverty, and he had few opportunities for improving himself.

At the age of eight, he was employed on a farm near Coopersburg, Pennsylvania, and the following year engaged to do the same kind of work near Frenchtown, New Jersey. During the next four years, he earned a living as a bootblack and newsboy at the Union Railroad Depot, South Bethlehem, not only supporting himself thereby, but also his widowed mother.

He then turned his attention to telegraphy. But that had to be abandoned owing to a lack of a common school education. A wider field opened to him, however, in the machinist trade, into which he threw all his energies. An apprenticeship of four and a half years was served at Shive's Steam Engine Governor Works in South Bethlehem, Pennsylvania. He was considered a good mechanic at the end of that time, and, having improved his evenings by studying mechanical drawing, working from models in the shop, he decided to perfect himself in his trade by working two years in two of the largest and best tool shops in Philadelphia.

At the age of twenty, he resolved to supplement his practical knowledge by a university technical education. There were great difficulties in the way, for during this time, he was the sole support of his mother, and his preparation had not been such as to make it sure that he could pass the entrance examinations. The financial difficulty was solved by the kindness of a generous friend, who forwarded sufficient money to see him through college.

In the summer of 1885, he accepted a place with the Hon. Eckley B. Coxe, of Drifton, Pennsylvania; he was put in charge of the splendid technical library belonging to his employer, and, in time, became his general scientific assistant and the Assistant Superintendent of the Testing Department of the Cross Creek Coal Company.

At the time of his death, he was a member of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the Society for the promotion of Engineering Education, the American Chemical Society, the New York Railroad Club, the American Railway Master Mechanics' Association, the American Foundrymen's Association, the Master Car Builders' Association and the North of England Institute of Mining and Mechanical Engineers.

In June, 1896, he was appointed Superintendent of Motive Power of the Delaware, Susquehanna & Schuylkill Railroad. In November of the same year, in

addition to his other duties, he was appointed Superintendent of Motive Power and Machinery of the Cross Creek Coal Company and the Coxe Iron Manufacturing Company. These positions he held at the time of his death. He died on January 21, 1899, at the early age of thirty-seven, of pneumonia.

A man's best monument is the work he leaves behind him. There exists a school which goes by the name of the Mining and Mechanical Institute of the Anthracite Coal Regions of Freeland. This was organized by Mr. Wagner in 1893, for the purpose of providing an education for men and boys of small means and few advantages. By means of this Institute, Mr. Wagner's career, short as it was, served to inspire more than one young man to seek a better and more useful life. Had he lived, his great purpose was to do similar work on a much larger scale. Now that attention is drawn to him by his death, the influence of his life will be felt in a wider circle than ever.

A. J. BELTZ.

THOMAS ALEXANDER FRASER.

Thomas Alexander Fraser, whose death occurred at Chicago, Illinois, October 13, 1898, was born in Canada, July 21, 1843.

He commenced work for the Chicago & North-Western Railroad Company in their machine shop at Chicago when about fifteen years of age; worked in that position a year and a half, then fired a locomotive the same length of time, after which he worked as locomotive engineer for three years.

He then accepted a position as first engineer on a Davidson Line (Mississippi River) steamer. In 1869 he commenced service on the Winona & St. Peter Division of the Chicago & North-Western Railroad as locomotive engineer, where he remained three years. He then accepted a position as mill engineer at Minnesota City, Minnesota.

In 1874 he resumed work as engineer of a river boat. After two years, he became connected with the Chicago, Milwaukee & St. Paul Railway as locomotive engineer and served as such about six months, when he was transferred to Mitchell, South Dakota, as Roundhouse Foreman. This position he held one year, when he was transferred to Sanborn, South Dakota, and promoted to General Foreman of the Iowa and Dakota Division. Five years later he relinquished this position to go to Minneapolis, Minnesota, as Master Mechanic of the Minneapolis, St. Paul & Sault Sainte Marie Railway. In July, 1890, he accepted the position of Superintendent of the Wells & French Company, Chicago, which he held until his death. He was also a director in the Wells & French Company.

He was married October 26, 1868, to Miss Cora E. West. His wife and two children — a son, James Earl, and a daughter, Ella Pearl — survive him.

He was a member of Odd Fellows' Lodge, and became a member of the American Railway Master Mechanics' Association in 1887.

Mr. Fraser possessed unusual mechanical ability, particularly in car construction, in which he was engaged during the last nine years of his life.

His integrity and genial personality impressed itself upon all those with whom he was associated.

His death is regarded as a personal loss by his former associates, employes and friends.

E. A. WILLIAMS.

JOHN L. WHITE.

John L. White died of pneumonia, in Danville, Illinois, June 4, 1894, in the eighty-third year of his age.

Mr. White was born in Springfield, Massachusetts, September 8, 1811, and moved to New York with his parents at an early age. He was married to Miss Harriette Wallace, of Troy, New York, whose death preceded that of her husband several years. Mr. White was a prominent railroad man in the early days of railroading, and after coming West was for twenty-two years Master Mechanic of the Evansville & Terre Haute Railroad. He was the inventor of a truck which was extensively used on different railroads. He was one of the first members of this Association, becoming identified with it in 1869.

After severing his connection with the road, he removed to Danville, Illinois, where he resided until the time of his death. He was a pure, devout man and member of the M. E. Church. He passed away as peacefully as in the sleep of childhood.

ALLEN COOKE.

O. DE YOUNG.

O. De Young was born at Baltimore, Maryland, October 19, 1859. Entered railroad service in 1875, with the Houston & Texas Central Railroad, at Houston, Texas, serving his apprenticeship there, and afterward working for that company as machinist.

After being with the Houston & Texas Central Railroad seven years, he went with the Mallory Steamship Line as machinist, remaining with that line one year. He next entered the service of the Texas & New Orleans Railroad Company as machinist, but was shortly afterward transferred to road service as a fireman, in which capacity he served three years. He was then used as machinist and extra engineer, and was transferred to Beaumont in that capacity. In January, 1889, he was appointed Roundhouse Foreman at Beaumont, and in July, 1889, was made Master Mechanic of the Sabine & East Texas Railway, which position he held until April 1,

1892, when he was appointed Master Mechanic of the El Paso Division of the Galveston, Harrisburg & San Antonio Railway. This position he held up to the time of his death, which occurred at El Paso, Texas, March 24, 1899. He became a member of this Association in 1893.

Mr. De Young was married, in 1881, to Miss Annie Bowers, of Houston, Texas, and leaves surviving him his wife and six children.

E. RYAN.

JOHN S. McCRUM.

John S. McCrum, formerly for many years Superintendent of Motive Power and Machinery of the Kansas City, Fort Scott & Memphis, died at his home in Kansas City, Missouri, March 20, 1899, from a stroke of apoplexy.

He was born in Juniata County, Pennsylvania, February 20, 1838, and entered the service of the Pennsylvania Railroad in 1854, as an apprentice machinist. After serving his apprenticeship, he went to Cuba in 1859, and was for four years machinist and engineer on the Havana Railroad. He was then for four and one-half years in the service of the United States in charge of water service, and Master Mechanic of the United States military roads, and after the close of the war served one and one-half years as locomotive engineer on the Kansas Pacific Railroad.

He went to the Kansas City, Fort Scott & Memphis February 18, 1869, as engineer, and from January 1, 1870, to April, 1895, was in charge of the Mechanical Department of that road as Master Mechanic and Superintendent of Motive Power and Machinery, ill-health compelling him to retire from active service in April, 1895. He became a member of this Association in 1871.

There is little need for comment as to Mr. McCrum's ability and character. His whole career may be summed up in a remark he made to me at one time, the purport of which was that during his entire official career he had never done one act of which he was ashamed. Those who knew him will appreciate this remark.

W. A. NETTLETON.

A. A. DANIELS.

A. A. Daniels was born at Springfield, Massachusetts, December 7, 1858. His education was partly received at that place and completed at Willimansett, Massachusetts. He learned the machinist's trade with the New Haven Manufacturing Company at New Haven, Connecticut, and was an engineer on the New York, New Haven & Hartford Railroad at the time of his marriage in 1883.

In 1886 he was employed by Mr. S. R. Tuggle, Superintendent of Motive Power of the Kentucky Central Railway, as toolmaker; early in 1887 he was placed

on the road as engineer, and filled the position until early in 1889, when he took charge of the drawing room of that road; in 1890 he was made foreman of the shops at Covington, Kentucky, and in 1891 returned to the position of engineer of the same road.

In April, 1893, he was appointed Master Mechanic of the Chesapeake, Ohio & South-Western Railway at Paducah, Kentucky. In May, 1897, he severed his connection with that company and took service with the Baltimore & Ohio South-Western Railroad at Louisville, where he was at the time of his death, August 22, 1897.

His death was from the effects of an operation for appendicitis. He left a widow but no children. He was a member of the Christian Church and a Freemason.

Every one personally acquainted with him unite in speaking of him in the highest terms as a man of the highest moral character and an agreeable associate, having all the attributes of a Christian gentleman. As an employe and officer he was equally well spoken of as faithful and capable. P. LEEDS.

FRANK BRUCE.

Mr. Frank Bruce, Master Mechanic of the Montana Central Railway, at Great Falls, Montana, died April 14, 1899, a wife and son surviving him.

Mr. Bruce was born at Newbury, New York, March 15, 1846, and served an apprenticeship with the Washington Iron Works. He was married near Newbury in 1869, and entered railway service in 1870. He was employed at Minneapolis, by the Chicago, Milwaukee & Saint Paul Railway Company, from June, 1870, until April, 1879; he was Foreman of the Machine Shops at Minneapolis, for the Minneapolis & St. Louis R'y, from April, 1879, until June, 1882; Foreman of the Roundhouse at Crookston, Minnesota, of St. Paul, Minneapolis & Manitoba Railway from 1882 until 1885, and Division Master Mechanic at Barnesville, Minnesota, from 1885 until 1887; Foreman of shops of Louisville & Nashville Railroad, at Louisville, from April, 1887, until February, 1888; Division Master Mechanic at Emporia, Kansas, of Atchison, Topeka & Santa Fe Railway, from 1888 until 1890; Master Mechanic of the Union Pacific Railway Company in Kansas, from April, 1890, until November, 1891; General Master Mechanic, Chicago & Eastern Illinois Railway at Danville, Illinois, from February, 1891, until November, 1891; Master Mechanic, Great Northern Railway, February, 1892, until February, 1893: Master Mechanic Montana Central Railway, at Great Falls, from February, 1893, until April, 1899, at the time of his death. He became a member of this Association in 1891.

Mr. Bruce was a thorough mechanic, popular with the employes, honored and respected by all, and possessed of many qualities which endeared him to all with whom he came in contact. J. O. PATTEE.

WILSON EDDY.

Wilson Eddy, for thirty years Master Mechanic of the Boston & Albany Railroad, died at his residence, 32 Cypress street, Springfield, Massachusetts, on the afternoon of September 2, 1898.

Mr. Eddy was born in Chelsea, Vermont, February 24, 1813. His early life was spent in Mount Holly, where he attended school, there getting the education which was later so amply supplemented by his active business experience. At the age of nineteen, he went to Lowell, where he was employed by the Locks & Canal Company, and in 1840 came to Springfield, where he entered the employ of the Boston & Albany Railroad.

Mr. Eddy was a thoroughly skilled mechanic, and during his forty years of active railroad life made a lasting impression on railroad mechanism. As an inventor and builder of locomotives he takes a distinct place in the history of the century. His were among the first practical locomotives built in this country, his first being the well-known "Addison Gilmore," which had but a single pair of drivers, and was named after the president of the Boston & Albany Railroad. He retired from active service in 1880, and at that time was presented with resolutions from the company, recognizing his long and faithful service.

He was an esteemed citizen of Springfield, having served the city government both as Alderman and Councilman, and represented his district in the State Legislature in 1882.

He was one of the first members of this Association, his membership dating from 1868.

T. B. PURVES, JR.

SUBSCRIPTIONS TO PRINTING FUND.

Alabama Great Southern	$ 3.00
Allegheny Valley	3.00
Ashland Coal & Iron Co	1.50
Atchison, Topeka & Santa Fe	15.00
Atlantic Coast Line	6.00
Baldwin Locomotive Works	150.00
Baltimore & Ohio South-Western	12.00
Boston & Albany	9.00
Boston & Maine	10.50
Brooks Locomotive Works	15.00
Buffalo, Rochester & Pittsburgh	12.00
Burlington, Cedar Rapids & Northern	10.50
Burlington & Missouri River	12.00
Cape Fear & Yadkin Valley	3.00
Central R. R. Co. of New Jersey	6.00
Central Vermont	9.00
Chicago, Burlington & Northern	7.50
Chicago, Burlington & Quincy	10.50
Chicago & Eastern Illinois	9.00
Chicago Great Western	9.00
Chicago, Indianapolis & Louisville	3.00
Chicago, Lake Shore & Eastern	4.50
Chicago & North-Western	15.00
Chicago, Rock Island & Pacific	18.00
Chicago, St. Paul, Minneapolis & Omaha	9.00
Chicago & West Michigan	9.00
Chesapeake & Ohio	10.50
Cincinnati, Hamilton & Dayton	10.50
Cincinnati, New Orleans & Texas Pacific	7.50
Cleveland, Canton & Southern	4.50
Cleveland, Cincinnati, Chicago & St. Louis	15.00
Columbus, Hocking Valley & Toledo	1.50
Columbus, Sandusky & Hocking	3.00
Columbus, Rome & Southern	6.00
Coster, E. L.	15.00
Delaware, Lackawanna & Western	7.50
Denver & Rio Grande	1.50
Duluth & Iron Range	6.00
Duluth, South Shore & Atlantic	6.00

Erie	$15.00
Fall Brook	9.00
Fitchburg	10.50
Florida East Coast	4.50
Fort Worth & Denver City	1.50
Georgia	7.50
Georgia Southern & Florida	1.50
Grand Rapids & Indiana	12.00
Grand Trunk	12.00
Great Northern	4.50
Hannibal & St. Joseph	9.00
Illinois Central	18.00
Intercolonial	1.50
International & Great Northern	6.00
Iowa Central	3.00
Kansas City, Fort Scott & Memphis	7.50
Kansas City, Pittsburg & Gulf	24.00
Lake Shore & Michigan Southern	15.00
Lehigh Valley	16.50
Long Island	3.00
Louisville & Nashville	25.50
Maine Central	9.00
Mexican Central	10.00
Minneapolis & St. Louis	6.00
Minneapolis, St. Paul & Sault Ste. Marie	10.50
Missouri, Kansas & Texas	10.50
Missouri Pacific	10.50
Mobile & Ohio	19.00
New Orleans & North-Eastern	9.00
New York, Chicago & St. Louis	9.00
New York, Ontario & Western	10.50
New York, Philadelphia & Norfolk	3.00
Nolan, P. J.	1.50
Norfolk & Southern	3.00
Norfolk & Western	18.00
Ogdensburg & Lake Champlain	1.65
Oregon Short Line	7.50
Pennsylvania	6.00
Pennsylvania Company	10.50
Philadelphia, Wilmington & Baltimore	13.50
Plant System	9.00
Pittsburgh & Lake Erie	9.00
Pittsburgh Locomotive Works	15.00
Portland Locomotive Works	7.50
Richmond Locomotive Works	9.00
Rio Grande Western	6.00
Rogers Locomotive Works	82.50

Schenectady Locomotive Works	$15.00
Seaboard Air Line	15.00
Southern	36.00
Southern Pacific	10.50
St. Louis & San Francisco	16.50
St. Louis South-Western	3.00
Terre Haute & Indianapolis	4.50
Texas & Pacific	9.00
Toledo & Ohio Central	10.50
Wabash	9.00
Western New York & Pennsylvania	12.00
Wheeling & Lake Erie	9.00
Winona & Western	1.50

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PAST PRESIDENTS.

H. M. BRITTON,	1868 to 1876.	Deceased.
N. E. CHAPMAN,	1876 " 1880.	Deceased.
J. N. LAUDER,	1880 " 1882.	Deceased.
REUBEN WELLS,	1882 " 1884.	
JOHN H. FLYNN,	1884 " 1885.	Deceased.
J. DAVIS BARNETT,	1884 " 1885.	Acting President.
J. DAVIS BARNETT,	1885 " 1886.	
WILLIAM WOODCOCK,	1886 " 1887.	Deceased.
JACOB JOHANN,	1886 " 1887.	Acting President.
J. H. SETCHEL,	1887 " 1889.	
R. H. BRIGGS,	1889 " 1890.	
JOHN MACKENZIE,	1890 " 1892.	
JOHN HICKEY,	1892 " 1894.	
W. GARSTANG,	1894 " 1895.	
R. C. BLACKALL,	1895 " 1896.	
R. H. SOULE,	1896 " 1897.	
PULASKI LEEDS,	1897 " 1898.	
ROBERT QUAYLE,	1898 " 1899.	